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REGIONAL PLANNING
PART XII—ARKANSAS VALLEY

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JUNE 1943

NATIONAL RESOURCES PLANNING BOARD

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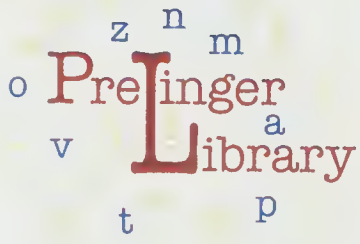

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REGIONAL PLANNING

PART XII—ARKANSAS VALLEY

NATIONAL RESOURCES PLANNING BOARD

JUNE 1943

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Director, Arkansas Valley Regional Planning Project

This report was prepared in the Dallas Office of the Board by a special staff under the direction of Mr. Edwin R. Henson and with the collaboration and assistance of the Central Southwest Regional Planning Council, Arkansas and Red River Drainage Basin Committees, the Board's Denver Field Office for Region VII (on the Upper Basin Problems), the State planning agencies of Arkansas and Oklahoma, the Water Resources Committee, staff groups of the Board's Washington office, personnel and data from several other Federal agencies, and the individuals named on page ix.

EXECUTIVE OFFICE OF THE PRESIDENT

NATIONAL RESOURCES PLANNING BOARD
WASHINGTON, D. C.

November 25, 1942.

THE PRESIDENT,
The White House.

MY DEAR MR. PRESIDENT: At your suggestion, we have brought together preliminary plans for the full use of the resources of the Arkansas Valley. The report, "Regional Planning, Part XII—Arkansas Valley," which we transmit herewith, contributes a long time approach to the development of the resources of the valley and to the improvement of the general well-being of some seven million citizens of seven States.

Within the Arkansas Valley are abundant resources: minerals, fuels, timber, agricultural products and manpower. At an early date, the readily available agricultural land was fully used and now the pressure on this resource limits the majority of farm families to the earnings from quite inadequate small farms. Industries did not afford sufficient alternate employment opportunities. The low income of the farming group is shared with the nonfarm group serving them, so that the purchasing power of all groups, is low. The unfilled needs of these people are tremendous and a great market for consumer goods, houses, furniture, clothing, etc., will come with the full efficient employment of the people.

The future opportunities for work are found in part in the proposed development of industry in the Valley. The abundant natural resources, the undeveloped power possibilities, the labor supply and the potential market are considered in planning for a great expansion in basic manufacturing industry and in service industries. The great need to protect the soil from erosion, to reforest land not suited for continued production of crops, to control floods, and to develop recreational facilities offer further assurance of necessary employment. All educational forces would be enlisted to assist the people of the Valley in making the best use of the resources of the area.

The report is confined to proposals of needed measures for full use of resources and does not concern itself with the choice of particular agencies or means for their accomplishment. The plan presented is designed ultimately to effect a combination of labor, land resources, capital, and power, which will give the people of the region full employment, utilize the resources, restore and maintain the fertility of the land, permit the region to make its full, rich contribution to the national wealth, and support the people at a level of living which will maintain a healthy and happy citizenry.

Sincerely yours,

FREDERIC A. DELANO, *Chairman.*
CHARLES E. MERRIAM
GEORGE F. YANTIS

NATIONAL RESOURCES PLANNING BOARD

FIELD OFFICE
DALLAS, TEXAS

September 24, 1942

MR. CHARLES W. ELIOT,
Director, National Resources Planning Board,
North Interior Building,
Washington, D. C.

DEAR MR. ELIOT: This is a preliminary plan for development and conservation of the resources of the Arkansas and Red River Valleys. Its formulation has drawn heavily upon the material available from the research and planning efforts of people and agencies at the community, State, and Federal levels. It will be useful, it is hoped, in calling the attention of the residents of the area to the possibilities of a more satisfactory use of resources, and in focusing national attention on the potential contribution which may be expected from a fully-developed region.

In presenting this report, your directive that it should primarily be an outline of what should be done, not how or by whom it should be executed, was adhered to. However, to the end that the plan be workable, its various phases have received consideration as to their practical accomplishment. From this consideration it is evident that the achievement of this plan will require a degree of coordination of the efforts of people and local, State, and Federal agencies which does not now exist in the area.

Within the suggested framework for the development of the area effective use can be made of present opportunities for adjustment. Community, State, and regional projects and programs may be expedited as they are in accord with the objectives of the plan, and national programs may be modified to contribute more directly to these ends. Full participation of the people in business, labor, and agriculture, of the educational forces, and of the universities, colleges, and research institutions is necessary if the objectives are to be understood and realized. The State Boards or Commissions dealing with natural resources and the expanded Regional Council and Regional Committees working with the Field Offices of the National Resources Planning Board are organizations through which this participation may be obtained.

Very great changes are now being made in the area. The national needs for manpower, for food production, for timber and forest products, and for industrial production are pressing the people of the area toward adjustments which are proposed in the report and which are believed, in the long run, to be highly advantageous to the region.

Each Federal and State agency and each individual and institution asked to cooperate in the preparation of this plan has responded wholeheartedly. Pertinent available information has been furnished gladly, and the agencies have given generously of the time of some of their personnel. The interest and the enthusiasm with which the designated representatives have worked indicate a genuine belief in the need for programs and plans to guide the adjustments in the area.

Sincerely yours,

EDWIN R. HENSON,
Director, Arkansas Valley Planning Project.

FOREWORD

This report advances a plan or framework within which it is possible for the people of the Valley to improve their own well-being through knowledge of what they have to work with and through forethought. On that solid foundation private enterprise and community, State, regional, and Federal effort can cooperate to develop and use all resources most efficiently.

The emphasis is upon the people and their use of the resources of the Valley. While the report constitutes a series of recommendations and suggests projects in certain fields, it does not attempt to indicate by whom the projects should be undertaken, the source of their financing, or the order of their initiation. Programs of action and plans for projects require further studies at community, area, State, and regional levels; the responsible State and Federal agencies should evaluate them and be in accord on their effectiveness.

Although the report is in the form of a suggestive general plan, it necessarily considers certain aspects of the program by which the plan could be effected. The program will be broad in scope; portions of it will require large investments of capital. If the program is to be truly that of the people of the Valley, individuals, communities, and local and State governments must be expected to share its capital cost to a degree commensurate with the benefits that accrue to them. Federal participation must be expected on a like basis and according to recognized Federal procedures.

To carry out the development by the democratic process will involve three principal and separate although related operations. First, the building of a background of public understanding of the potentialities of the region, through education and public participation in discussion and planning. Next, the correlation of all phases of development planning, so that the general plan and program are truly comprehensive, reflecting public participation, and eliminating conflicts as they arise. Finally, action programs springing from the planning efforts must be efficiently carried out. The first two steps, intelligently taken, will make easier the third.

Clearly, these steps can be taken successfully through several possible administrative procedures. The administration could be achieved by existing agencies, by a regional authority, or by other intermediate means. It is not intended that this report shall imply which is the most desirable method for this area. However, it is evident that further correlation of the activities of existing agencies or the creation of new coordinating machinery is necessary to translate the plan herein presented into a program of practical accomplishment.

ACKNOWLEDGMENTS

The following people have made material contributions to the preparation of this plan:

Earl H. Bell, Bureau of Agricultural Economics, Albuquerque, N. Mex., population.

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REGIONAL PLANNING—PART XII
ARKANSAS VALLEY

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PART I. THE ARKANSAS VALLEY

The Arkansas, Red and White Rivers and their tributaries drain a great area 800 miles long and half as wide, including almost one-tenth of the land area of the United States. Beginning in Colorado and New Mexico, the area drained by these river systems extends down from the arid eastern slope of the Rockies across the High and Rolling Plains and the rolling, broken prairies in Kansas, Oklahoma, and Texas to the humid, hilly, heavily wooded Ozark-Ouachita Highlands of Missouri and Arkansas, and further south to the Forested Coastal Plains of Arkansas, Louisiana, and Texas. Natural contrasts in topography, climate, soil, and other resources are very great.

Certain statistics are compiled encompassing the entire drainage basins of the Arkansas, Red and White Rivers. However, the general social, economic, industrial, and organizational recommendations are not meant to apply to the portion of the area in the alluvial plain along the Mississippi River nor to the Arkansas River watershed above Garden City, Kans. These areas differ materially from the main body of the watershed. The watersheds of these three rivers, with the exceptions noted, are referred to as the Arkansas Valley in this study.

This is an area of great natural wealth and opportunity, capable of supporting its people at the highest level of social, cultural, and economic life and capable of enriching the national economy. Its potentialities, however, lie relatively dormant while the mass of its citizens have not normally had adequate opportunities for jobs in which they can produce efficiently and earn a fair wage.

The potential peacetime productivity of the people of this area has been amply demonstrated by their performance in agriculture and industry during the war.

The Wealth of the Valley

Few areas in the world have been so richly endowed by Nature with the resources and materials necessary to support a balanced agricultural and industrial economy and to provide for a high standard of living to all of their inhabitants.

The people—7½ million of them—are a great asset of the Valley. They serve the Nation now, contributing more than their quota to the armed forces; they fill every local war industry with workers; surplus labor migrates to other areas and, still, the mass of people of the valleys is underemployed. When tools and equipment are available and trained workers are efficiently operating the present farm lands, services, and industries, they can also fill over 1,000,000 new jobs adding the products of their labor to the wealth of the Valley and Nation.

The agricultural resources are well suited to diversified agricultural pursuits and can contribute greatly to the present and future requirements for dairy, poultry, beef, vegetables, fruit, and fiber products. The farm business requires reorganization as two-thirds of the farms are small and provide but bare subsistence to the operators. Many improvements can be made and many thousands of workers may move to more efficient production in manufacturing or service industry.

A very large share of the petroleum and mineral resources of the Nation are located here. The forests contain great quantities and many varieties of soft and hardwoods. Supplemented by the products of agriculture, these resources comprise the essential materials for many industries.

Enormous quantities of low-cost fuel—natural gas, coal, and petroleum—and the large potential of undeveloped hydroelectric power are readily adaptable to the generation of low-cost power. Greatly expanded power at low cost to commercial and domestic power users will further the full use of the resources of the Valley.

These four great assets—the people providing a great labor force; the extensive reserves of minerals, fuel, and timber; the favorable opportunities for the production of low-cost power; and the agricultural productivity of the region—form the foundations upon which the future of the Valley may be built.

Economic Status of the People

The Valley was settled in the best pioneering tradition. Hardy people devoted themselves to harvesting the timber, clearing land, breaking sod land, producing agricultural products, and shipping these materials to the centers in the East where they were needed. While doing this work, they lived in makeshift houses and worked strenuously to make a living from the relatively poor soil in the eastern part of the Valley, and under a relatively hazardous climate in the western part. As in other pioneering areas, both wages and requirements were low.

Many years ago the agricultural resources of the Valley were adequately manned, but the population's rate of natural increase remained high—much higher

than the increase in new jobs. The surplus workers sought opportunities in agriculture, dividing farms into smaller and smaller units and forcing the cultivation of millions of acres of land which, in the interests of soil conservation, should never have been plowed. This cheap labor has made the use of more efficient machinery unnecessary and the production of labor has remained low, providing incomes to the majority of farm families sufficient only to support bare subsistence levels of living.

The overflow of agricultural workers has sought employment in nonfarm communities and cities within the region, creating and maintaining a surplus of labor. In the small towns and cities serving rural areas, the business men and others are drastically handicapped by the lack of purchasing power of their customers. Wages in industry and service are generally low in most parts of the Valley as there have always been more workers than jobs, more goods and services than customers with purchasing power.

Failing to find adequate opportunities for employment in the Valley, workers have left the region in large numbers—2 million since 1910, half a million in the early thirties.

The per capita income in 1940 in the States wholly or partially in the Arkansas Valley was as follows: Arkansas $277, Kansas $413, Louisiana $366, Missouri $499, New Mexico $363, Oklahoma $355, and Texas $423. All of these States average less than the Nation as a whole and the weighted averages of the combined group of States is $235 per person less than the national average. The income of the Valley would be raised by $1,739,000,000 if volume of production and prices received were equal to the average of the Nation. The resources of the Valley when developed can raise the income well above the average for the Nation. Such an increase would practically double the volume of business in the Valley.

Opportunities for efficient work with adequate land, equipment or tools are not available. Without these things the volume of product or work per worker is too small to give an adequate income. This low income is shared with the persons serving farm people, tending to restrict all phases of business, medical care, education, recreation, the general welfare and development in the Valley.

Thus, the problem of first importance in the Valley is that of providing the means whereby the people may direct their unused energies into productive channels so that through their efforts they may raise their standard of living and contribute more to the wealth of the Valley and of the Nation. With the abundance of working materials and resources within the region there can be no question but that in the national interest this unused labor supply should be utilized largely in the Valley. Eventually, if properly developed, this region may absorb and support in-migration from other areas of the United States which have similar pressures of labor supply, but which are less favorably appointed with natural resources and opportunities.

Opportunities for Additional Employment

The people of the Arkansas Valley are engaged, largely, in the production of raw materials on the farms, in the forests, and in industry. Power or machinery are not used extensively to produce or process these raw materials locally, rather, they are being extracted and shipped out of the Valley. The many industrial advantages of the area encourage the belief that industrial expansion, including manufacturing and the miscellaneous group of trades called services and service industries, offers the long-range opportunity for full employment which will give balance, variety, and stability to the regional economy.

The Valley will continue to produce and export raw materials, but at the same time industries will be established or expanded to produce finished consumer goods. This industrialization will provide for many of the things so badly needed for the reasonable well-being of the families of the Valley and will supply equipment and tools for increasing production in other fields of work. The increased employment will raise the per capita income of the people and move a great mass of the population in the eastern half of the Valley from bare subsistence into the active consumer group. The expanded markets created will, in large part, absorb the industrial output. The remainder will comprise an addition to the national wealth as well as articles to exchange for the products of the other regions of the country and of the world.

Additional and related opportunities are to be found in the further development and conservation of the resources. The rivers, potential sources of abundant electrical power and valuable also for water supply, recreation, irrigation, and navigation are not adequately developed for these purposes. Floods annually cause great damage. A comprehensive program for multipurpose development of the rivers is outlined and will afford employment for many workers and contribute greatly to the economic welfare and well-being of the people of the Valley.

The land and forest resources are deteriorating under the pressure of use. A very great effort is required to conserve the soil, to reforest and regrass lands better suited to these purposes than to cultivation of crops. Neglected forest lands must be brought under better forestry practices. Land treatment to prevent flood damage and silting of reservoirs is required. Recreational developments, road construction and improvement, and numerous construction projects for housing

people, providing factory buildings, schools, public buildings, etc., afford additional opportunities for efficient employment of workers.

In the present war program the Nation's pressing and immediate need for manpower and materials finds the Valley a productive source of supply. The war program brought a number of war industries to the Region. Unemployment has dropped considerably and the people are much more effectively employed than heretofore. However, even under the present stress of wartime conditions, the Valley still has a large reserve of manpower. Much can yet be done to release underemployed workers for immediate transfer to war jobs. Whatever is accomplished during the war toward the more efficient use of the area's men and resources should be utilized as the first step—the lever—by which the Arkansas Valley Region may begin to lift its economy into line with forward-looking developments elsewhere in the country.

The Part of the People

Full employment and full utilization of resources will demand deep-seated adjustment on the parts of millions of the Valley's people. The implementing of specific proposals relating to people, land, water, industry, and power calls for individual and group adaptations to, and participation in, the various steps.

Any democratic program for conserving water, land, and mineral resources must rest on and grow out of popular attitudes which put correct values on these regional assets. Adjustments in agriculture must proceed with understanding and application of more effective farming methods and with greater appreciation of the value of efficiently-sized farm units. Industrialization implies more than mechanization; along with it must come the development of leadership of an industrially minded public and of workers trained in the skills required.

The adjustments necessary to meet the goals of full employment and full utilization should not be instituted without assurance that the people of the Valley will participate and will have an intelligent understanding of their operation and purpose. Above all, one thing is clear—implementation of the plan herein proposed must spring primarily from the will of the people; its accomplishment must rest upon their efforts.

PART II. A PLAN FOR THE ARKANSAS VALLEY

All of the resources required for the highest standard of living are present in the Arkansas Valley. The problems of the Valley are primarily those of adjustment.

Important adjustments are required in education to arouse the people to the great possibilities of their Valley; in agriculture to conserve the forest and soil resources and to provide adequate farm units for farm families; in industry to stimulate expansion of processing and conservation of raw materials; in power development to provide industry and domestic users with the relatively low-cost power that can be had from the streams and abundant cheap fuels of the area; in labor to increase output per man through training and use of modern tools and equipment; and in greater personal efficiency through improved standards of living including medical care, housing, household furnishings, tools, food, clothing, and recreation.

Fundamental objectives of the plan are to provide opportunities for effective work for all who want jobs, and the full utilization of resources both during and after the war. The plan is an attempt to point the way toward a coordinated effort to meet the immediate problems of the Valley now, and in accordance with desirable long-time adjustments.

Actual application of the plan will necessitate changes and modifications of some of these specific suggestions. However, its basic concepts and aims are believed vital to the rounded development of the Valley economy.

Adjustments in Agriculture

In describing conditions in a broad area such as the Arkansas Valley, exceptions can legitimately be taken to the universal application of the description inasmuch as there are areas admirably adjusted at present. The generalizations are not made unless they are predominantly true for the broad area.

More people in the Valley are dependent for their livelihood directly on farming than on any other type of work. Many in the rural nonfarm group who perform service functions for farm people are directly affected by earnings in agriculture.

General Problems

Even if farmers everywhere were to receive parity prices for their products, the majority of farmers of the eastern portion of the Valley would still have inadequate incomes because production per man is too low. Soils are generally poor, yields are small, production is limited. People of the Nation cannot afford to pay these farmers the prices which would be required to provide them an adequate living from their limited production.

The great effort at conservation of the soil has had the support of practically everyone, yet the achievement of proper conservation has been rendered extremely difficult, if not impossible, by the fact that the majority of farmers in the eastern half of the region operate farms of insufficient size, and have practically no funds with which to carry out conservation measures.

The problems of agriculture in the region have been given a great deal of attention by agricultural workers and groups of farmers throughout the area. Research and educational efforts have been directed toward the solution of farm problems. Such work has been supplemented by the activities and financial help of national farm programs which are vital to the welfare of the area. However, the pressure of people on the land continually interferes with these efforts to attain a really satisfactory agriculture.

Loans and grants are not likely to rehabilitate these people, unless adequate expansion of their land base is included. This in turn means that operation of many small farm units must cease. In the interests of full, efficient employment of the people of the Valley, and an adequate level of living for all, this step is of utmost necessity.

The agricultural income for the Valley was roughly 615 million dollars in 1940. This is $189 per capita for the 3,255,000 people on farms. This income is not evenly distributed as approximately one-fourth of the 646,000 farms produce the bulk of the agricultural products sold from the farms. The average income of the people on the remaining 484,000 farms was less than $40 per capita.

These small farms are not adequately equipped with livestock, tools, and equipment to operate efficiently. The soil on many of these farms is not suited to crop production and is rapidly being drained of its remaining productivity to support the farm families who, though normally employed, are limited to little more than bare subsistence. They are not contributing materially to the agricultural needs of the Nation nor are they buying many of the products of industry.

In some limited areas farm families and their hired labor have reasonably satisfactory incomes, homes, health, services, and enjoy a real sense of security. Such communities will be found in the diversified wheat-live-

stock area of south central Kansas and north central Oklahoma and in other portions especially in the fertile valleys of the streams.

Many adjustments are required to afford an adequate income to farm families and to contribute to the full use and conservation of the land resources. Land should be put to its most productive use, worn or abandoned cropland returned to grass or trees with suitable conservation measures in use generally. Surface waters must be controlled to avoid flood damage and water developed for use in irrigation, water supply, recreation, and power. In many areas drainage and levee construction will make possible more productive use of additional lands. With these adjustments must come a reorganization of farms into efficient operating units. Finally the contribution of the great forested areas must be improved through better management.

Conservation of the soil.—In the eastern half, much of the surface soil in the plowed fields has washed away and a very elaborate program of terracing, strip cropping, green manuring, and fertilizing will be required to check further loss and build back its productivity. In the western half, the damage from water erosion is not so severe, but a combination of high winds and dry climate make wind erosion very severe on the lighter soils.

The climatic conditions and the topography of the soil combine to make tillage of the rolling lands hazardous. The small operator with inadequate equipment or funds finds the task of controlling erosion very difficult. These conditions in part account for the disastrous erosion now evident. Some idea of the real condition is implied in the estimate by conservation technicians that 1,800,000 man-years of work would be required to check erosion and to accomplish other necessary conservation and restoration work on the crop, pasture, and forest lands of the Valley.

Major shifts in use of land.—To attain best use of the land throughout the region, shifts between various crops, grasslands, and forested areas would be needed, and should be included in the regular conservation plans for farms. In addition to these normal shifts, other adjustments are required which are so difficult to perform that they cannot normally be carried out by the individual farmer. One such adjustment is the return of worn or abandoned cropland to grass or trees for proper land use. Some 17,400,000 acres of such land should be regrassed or reforested. This includes wind-erosion areas in the West which are extremely difficult to return to grass, and forest lands and eroded croplands in the East which require special forest management. (See fig. 5.)

Need for irrigation.—West of the 98th meridian, rainfall is uncertain and insufficient for consistent crop production. Frequent droughts occur, with occasional sequences of years of partial or complete crop failure. Under these conditions, dependence on range lands or on dry-land crop production often causes wholesale abandonment of farms or drastic or complete dispersal of livestock range and breeding herds. Irrigation from either surface water or underground water is the only certain means of maintaining a constant supply of feed, and the only way of providing gardens, trees, and a feed reserve, all of which add tremendously to the security and satisfaction of life on the plains.

Irrigation projects of the Upper Arkansas produce specialty crops, food, and forage, and support a livestock feeding enterprise. Available waters in the tributary streams should be developed for irrigation to make full use of the resources and to bring greater security to farm families in this area.

Flood-control structures are needed to prevent damage to irrigation works and to crops on alluvial bottom lands. Such structures should be far enough upstream to obviate maximum damage and at the same time afford use of some of the waters collected for irrigation of the lands below the dams.

An additional 320,000 acres may be irrigated from surface waters in the region west of the 98th meridian. This additional irrigation would do much toward bringing about full use of the water of these streams. For example, on the North Canadian River only 1,350 acres are now irrigated. The proposed projects would provide water for 41,700 acres and would effectively utilize the surface water available in the basin. The waters of the Arkansas are fairly well utilized. Of the 1,150,000 acre-feet annually available along the upper Arkansas River, only 170,000 acre-feet are now unused. The completion and operation of the John Martin Dam project will reduce this about one-half, making effective use of practically all of the waters of the upper Arkansas.

Although studies have not been completed, the need for water is so great in the western half of the region that importation by transmountain diversion is urged, provided any available waters can be so diverted at reasonable cost. Such waters would contribute to the development of hydroelectric power as well as irrigation in the area.

Small-water facilities.—Irrigation of small, scattered tracts of land by surface storage is highly desirable. The construction of small dams, either privately or through the Water Facilities Program of the United States Department of Agriculture, will make possible the use of unappropriated waters on the small tributaries of the larger streams. It is roughly estimated that an additional 50,000 acres may be irrigated by this means in projects ranging from 25 to several hundred acres.

Ground water.—In the High Plains especially, opportunities still exist for pumping underground water for

irrigation purposes. However, lack of comprehensive and adequate ground-water investigations and suitable legislation based thereon for regulating the spacing of wells and other controls makes this development hazardous. Approximately 117,000 acres, mostly in Kansas and Texas, are now irrigated from ground water. It is estimated that, under suitable State legislation and regulation, an additional 50,000 acres could be developed.

Reduction in flood damages.—In the alluvial valleys, floods frequently do great damage to agricultural crops, farm lands, roads, cities, and other developments. Surveys indicate an average annual damage of $25,500,000, with approximately $19,500,000 of this damage to agricultural lands and the remainder to roads, cities, and other developments.

In the eastern part of the area the hill lands usually produce the feeder livestock, while the rich bottom lands produce the grain and high-cash-value crops. Because of these and other relationships, any damage by floods to the lowlands has a regional significance and flood control is vital not only to areas protected but to agriculture and institutions in the surrounding area.

Previous studies of the Valley streams have been reviewed and a system of reservoirs planned which would reduce the average annual loss from floods to $12,900,000. Locations of the reservoirs and dikes required to bring about this control of floods are indicated in fig. 9.

In addition to the dams and levees, the conservation program should include agricultural land treatments which reduce erosion and the deposit of silt on lands and in reservoirs farther downstream. Upstream structures and land treatments tend also to delay the movement of water into the main channels and reduce the peak volume of floods.

Rice irrigation.—In the Grand Prairie region of eastern Arkansas, 125,000 acres of rice are grown annually in rotation on some 450,000 acres adapted to rice production. Irrigation facilities already developed have been pumping water from underground sources which are now seriously overdrawn. As a result, the water table has been critically lowered, and a temporary reduction in irrigation of rice in this area is required. When the proposed multiple-purpose reservoir system is in operation on the White River basin, the increased sustained low flow of this river will comprise a logical source of additional water supply.

Extensive possibilities for rice production exist in the Oak Flats area west of Crowley's Ridge and in neighboring areas. In all of this development, legislation is seriously needed in Arkansas for the control of the use of underground water. Rice can be produced in abundance here when markets justify increased production.

Drainage.—In the lower reaches of the Arkansas and Red Rivers and their tributaries, production losses result from inadequate drainage. Numerous local drainage districts designed to care for particular areas are not properly integrated with areas above and below. State and Federal engineers are seeking means of coordinating and blending activities in these districts in a systematic approach to the drainage problem. This effort should be encouraged and assisted in every way possible.

Reorganization of farms.—The agricultural resources of the region are now deteriorating, but the rate of loss will be materially reduced and an opportunity for gradual recovery will be made possible when adequate conservation measures are widely adopted and when shifts in land use and other developments are carried out. This program will require years for its complete accomplishment. It can only be maintained by relieving the pressure of people on the land and by establishing efficient farm units that enable farmers to care properly for the resources.

In many communities, committees of farm people have studied the size of farms and the enterprise required to provide an adequate level of living for a farm family. These recommendations call for a minimum annual cash income of $700 to $800 per farm. (See Part III, "Levels of Living.")

Approximately 58 percent of the farms in the Valley, especially in the eastern and southern part, are incapable of providing a cash income sufficient for an average family of five. However, the enlargement of many of these small units by combining them with other similar units, and the shifting of the surplus people to other work and the land unsuited to agriculture to other uses would make possible the average annual farm income of $700 to $800 to the remaining farmers.

The total number of farms in the Valley which must thus be absorbed in other units is 212,000, or a reduction of from 646,000 to 434,000. The extent and distribution of the reduction in subregions of the Arkansas Valley is indicated on figure 7.

If this shift were carried through to completion, 444,000 agricultural workers would be released for other pursuits. However, since the entire shift probably would not be feasible because of the age of many of the farmers, and their unwillingness to enter other lines of work, an actual reduction of 320,000 workers is proposed.

The type of adjustment necessary to establish adequate family-size farms varies with the predominant type of agriculture. In general, however, there should be two major types of adjustments, one for the western half of the Valley, and one for the eastern half.

In the western area, except in the irrigated portions,

the chief factor in the reorganization is the need for enlargement and diversification of farms to bring security to the operator under the hazardous climatic conditions which prevail. Frequent droughts and sequences of drought years make it necessary that the operator have means of maintaining his investment through these hard times. Many residents of the area have modified their system of farming to meet these conditions, but the small operator and the speculator repeatedly disturb the local economy. From the time of the first settlement until the present there have been three or four periods in which wholesale abandonment of farms occurred. In each case, streams of broken and disheartened people departed. The continuity of community life was destroyed, institutions devised to serve the area could not be maintained, and those people who did remain were burdened with heavy institutional costs.

Small farms should be combined into much larger units capable of providing grass for cattle, as well as sufficient land on which to raise feed and grain crops. Through a program of crop insurance, the storage of an adequate reserve feed supply in trench silos, and a wise use of irrigation water, agriculture in this area can be stabilized. Community action and educational programs will be required to avoid the plowing of lands which can become wind erosion hazards, and to check promotional developments which would establish people on farms of insufficient size.

Irrigated areas could assist in stabilizing agriculture in the region first by the assured production of feed from these areas in drought years and by participation in an ever-normal "feed bin program" to store feed in good years for use in times of dry years. This program would make it possible for the man on an irrigated farm to sell his hay at a reasonable price in wet years when there is an abundance of feed throughout the region, and would at the same time provide feed at reasonable cost to the livestock man in years of drought.

Other improvements proposed for the western area include less complete reliance on wheat production and the adjustment of livestock numbers to the carrying capacity and feed-producing capacity of the farm. Where recurring droughts may make it impossible for a farmer to meet his annual obligations, it is necessary that credit agencies adopt a system of repaying obligations which takes into account frequent crop failures. All credit should be extended on a variable-payment basis, which permits the carrying over of obligations in drought years and assesses payments annually on the basis of area production.

In the eastern half of the area, the adjustment plan should include an increase in the production of meat, dairy products, poultry, fruit, vegetables, and oil crops. This would make it possible to discontinue cotton production on the poorer upland soils throughout the eastern half where yields are low. Cotton grown in these sections requires much more human labor for chopping, hoeing, and picking than the returns justify.

Should an increase in short-staple cotton be required at any time, it can be achieved by relaxing acreage limitations in the rich alluvial lands and on the western plains where cotton can be produced more efficiently. This shift would seem to be more in line with probable world and national markets and greatly to the advantage of the region and of the people on the farms.

In the eastern half of the Valley expansion of dairy, poultry, hog, and to some extent beef cattle production—generally advocated for years—is still handicapped by the lack of an assured source of protein and carbonhydrate feeds and pasture. Before the livestock industry can be expected to be established in this area on a profitable basis pastures must be very greatly improved and concentrated feeds, both proteins and carbonhydrates, produced and distributed to farmers in a much more efficient manner than they are handled at present. The livestock industry is not likely to expand greatly in this area on the basis of high-priced imported feeds. While some advantage might be had in reorganization of the method of handling of imported feeds, it is believed that far more progress can be expected by the adaptation and processing of locally grown feeds.

Such crops as sweet potatoes, peanuts, cottonseed, sweet sorghum, sugarcane, grain sorghum, soybeans, corn, and other southern crops must be relied upon to produce these feeds. Through properly equipped cooperative feed preparation and mixing plants these local feeds can be prepared and blended into excellent rations available at reasonable prices to farm people. Experiment stations are now considering this feed problem and farm organizations should interest themselves in the organization of this vital enterprise for efficient, probably cooperative service.

When the shift in agricultural production is made, attention must be given to equipping the farms with sufficient machinery and livestock, and to the construction of adequate housing. A movement toward mechanization of agriculture, heretofore unnecessary and even undesirable because of the abundance of labor, is now required. Displaced agricultural labor will have a permanent function to perform in industrial work, in services, and in the distribution of goods needed throughout the area.

Forest conservation and utilization.—In the eastern half of the watershed, forests represent the dominant use of land and occupy about two-thirds of the area. The forest area of the future will, in all probability, be approximately equivalent to or only slightly less than the present forest acreage. Future land clearing

and reforestation of submarginal lands will be approximately equal.

After a half century or more of exploitation, these forests are producing wood products in prodigal quantities in large part because of their rapid rate of growth and a great capacity for perpetuating themselves in spite of abuse; they produce in increment, annually, the huge total of 3½ billion board feet of saw timber or more than 1 billion cubic feet of all products combined.

The forests are being cut at a more rapid rate than they are producing new wood increment. Under the stimulus of wartime markets, present drain doubtless exceeds increment by a considerable margin, and the growing stock is being depreciated in both volume and quality. The major part of the cut is exported from the area largely in raw, unprocessed form.

Present annual saw-timber increment on an average acre ranges from less than 25 board feet in the poorer upland hardwood stands to about 175 board feet in mixed pine types. Potentially, annual growth ranging from 150 to 500 board feet of saw timber per acre can be produced in these stands.

Privately owned forest lands, comprising 90 percent of the total forest area, largely lack management and care. Ordinarily, timber is cut without regard for probable rates of replenishment.

Inadequate efforts are being made to protect the forests and to reduce mortality losses. Fire-control programs are locally effective but annually fires burn unchecked over extensive areas that are largely without protection of any kind. Livestock usually has free access to woodland areas, destroying reproduction and impairing watershed and other values. Decay and insects take a further heavy toll.

Utilization problems are of first moment. The forests contain huge volumes of low-grade unmerchantable or silviculturally undesirable trees, chiefly hardwoods, for which new markets and uses are urgently needed. Milling practices are commonly wasteful due to inefficient equipment or lack of facilities for converting wood waste into byproducts. Local wood manufacturing plants are few and process not more than 10 percent of the area's output of wood.

The forests support varied and extensive industries which provide employment for more than 132,000 wage earners and livelihood for a gross population estimated at more than half a million people. This compares with a population of more than 2,000,000 people which, it is estimated, the forest lands might support, once in full productivity.

These forests contribute many subsidiary services which need strengthening. Protection afforded soils, water, and other watershed values is economically important, but this service is far below potential effectiveness because of misuse. The forests also shelter and sustain an important wildlife resource which has been greatly depleted. Forest recreation, although as yet largely undeveloped, is a prime resource which deserves special attention.

A primary need throughout the forested area is a market for raw products of the forest. People will not devote a great amount of energy to the care and management of forests and forest lands unless there is a market available for the products and a measure of profit to the individual can be expected. Establishment of these markets is expected in connection with the expansion of industry in the area.

Throughout the wooded areas also the meager standard of living in rural areas dependent more on the crop production from limited cleared areas without an equitable interest in the products of the forest land induces exploitation and lack of care of the forest resource. Systems of tenure in the timbered area which give some inducement for the proper care of forest resources are essential. Tenants on a 1-, 2-, or 3-year lease are not likely to give proper care to the forest resource on the lands they are leasing.

Suitable long-time credit for use in developing and managing forests is not now available. This credit should be provided to furnish funds for purchase, development, and management of forest lands, intermixed with farm lands, in family sized units.

Taxes on forest property are frequently locally burdensome and should be adjusted to long-time earnings of the land with requirements for proper management of the resource.

Forest restoration on a large scale is required. This will require the full cooperation of the timberland owners and the local public. The educational and technical services must be greatly expanded to establish in the minds of the public concepts of what improved practices involve and what this care can contribute in the way of increased income.

It is estimated that 13,400,000 acres of forest land should be publicly acquired. Eleven million acres of these lands are in the Ozark-Ouachita subregion, 1,400,000 in the Forested Coastal Plains, and 1,000,000 in the Cross Timbers area. These lands would be acquired by local public agencies, by the States, or by the Federal Government through the Forest Service.

Implementing Agricultural Adjustments

A much greater coordination of activities is desirable in the efforts to reduce flood damage, develop irrigation projects, classify and properly use the land, establish new and manage established forests, control soil erosion, reorganize farm units, provide drainage, etc. This increased coordination would seek to integrate all of these efforts so that the interests of the people of the Nation, Region, State, and community as

well as the individual benefited are adequately considered. Adequate organization, financial assistance, and authority are not available now to effect this coordination.

The farm people, through their community organizations and institutions and their committees for planning and cooperating with State and Federal agencies, should have major responsibility for the local planning of agricultural adjustments. Assistance in such local planning is available through the county agents of the Agricultural Extension Service and through vocational teachers in some communities. Local organizations for specific areas, such as Soil Conservation Districts and other units of government, may be very helpful in both planning and carrying out the plans.

In broad subregions and at the State level, State Agricultural Planning Committees and State Planning Boards would organize the efforts to prepare working plans for these areas. The authority and the mechanisms for carrying out many of the adjustments are available now through Federal and State programs.

Major shifts of workers from agriculture to industry will come voluntarily when the opportunities for a better level of living are developed in other fields. The credit organizations will be expected to assist in establishing adequate farm units through their extension of credit for additional purchase of land by small operators.

An expansion of the Tenant Purchase Program under the Bankhead-Jones Act, could provide the funds and the guidance to a program designed to establish families on adequate farms. The amendments now limiting the Tenant Purchase Program would have to be modified to permit the purchase of larger farms.

The pressure for manpower for the war effort is expected to entice small farm operators and subsistence workers into industry or agriculture on more productive lands. This shift should be encouraged in the interest of the Nation's production effort and for the welfare of the farm people. As these operators leave, the small farms will be absorbed into more efficient farm units. The movement of workers from the area will make the use of larger machinery more profitable and further aid in expanding the production per man in agriculture in the region.

The general use of electricity on the farms is contemplated, along with the expansion of power facilities in the Valley; the conveniences of urban electrical development are to be brought to rural areas at reasonable rates. Feed grinding, sawing wood, lighting, refrigeration, power for water systems and other services can come from the extension of electrical lines through REA and otherwise, to add greatly to the satisfaction and earning power of people on the farm.

Some form of public control is required over land use practices that tend to destroy the continued usefulness of the land. This control is essential now in critical areas subject to wind erosion and water erosion and in certain areas suitable primarily to forest production. Such control may be in the form of regulation to stop plowing of grasslands subject to wind erosion or requiring erosion-control measures on lands subject to severe erosion or to stop wasteful and destructive processes of conversion and burning on forest lands. Public ownership of these critical lands is another method of control. Where the land offers opportunities for private enterprise, public control measures are desirable; where land is impoverished by erosion, public ownership may be best.

The States now have a big task ahead in providing some form of management and control for the many thousands of acres of tax-forfeited lands which annually clog the assessors' books. State legislation for the management of these lands is usually required. Notable progress has been made by several States in this regard. Such lands should, after a lapse of 2 or 3 years, be taken off the market and consolidated into units for forest or range management. Their restoration and care will not only provide an opportunity for useful public works, but will also be a source of steady income to the community.

Adjustments in Industry

The Arkansas Valley is not now adequately developed industrially. Most of the industrial development that has taken place to date has consisted of extracting or assembling raw materials and shipping them from the area to centers where markets were available, thus establishing a colonial relationship between the Valley and outside industrial areas. Unfavorable transportation rates, inadequate credit, and other handicaps in the economy of the area have served to maintain the kind of industrial organization which fails to provide the local purchasing power of processing industries based on local materials.

Thousands of workers in the Valley have been compelled to leave in order to find employment. Many thousands of others, however, have preferred to remain near their homes even though opportunities for work were few. In 1940 and 1941, some 315,000 people in the Valley were unemployed, and under-employment was so general in the villages and towns that another 190,000 workers needed new jobs. To this great group of persons available for the national war effort must be added the 320,000 under-employed agricultural workers. Further, the labor force is being augmented at the present time by the addition of women and by a limited number of men not heretofore classified as laborers: there are 310,000 people in this group.

In using the manpower efficiently and fully this

region could furnish workers for an additional 1,135,000 jobs over the normal peacetime employment. Many of these people are now working in war industries. A great many more can and will be available as the pressure for manpower causes reorganization of our efforts to use labor and machinery more effectively. After the war old industries should be expanded and new ones established to utilize approximately 1,000,000 workers in additional jobs in manufacturing and services. The increased standards of living would be obtained by the addition of the products of this increased work rather than by any form of subsidy.

Manufacturing

Manufacturing industries in the Arkansas Valley can and should expand. The natural advantages of the area justify such an expansion.

1. *Labor.*—An abundant supply of labor is assured for the suggested future industrial expansion in the Valley; those who are available for work will readily respond to any calls within the region for workers paid reasonable wages. Moreover, the normal increase in population adds thousands of workers to the labor force annually.

Experience of newly created war industries proves that these workers are adaptable and can readily be trained for skilled work. A much greater emphasis by the educational system on training of workers in manufacturing and industrial skills will further assure an adequate supply of competent laborers in the region.

2. *Power.*—Surveys of streams in the Valley, notably those in the Ozark-Ouachita Highlands, show a great volume of undeveloped hydroelectric power. There should be a considerable increase in the development of power dams, and an expansion of steam-power plants sufficient to supply a greatly enlarged industrial development. Less than 10 percent of the hydroelectric power potentialities of the region have been developed. No other region is so favored with an abundance of low-cost fuel in the form of coal, lignite, natural gas, and petroleum as this area. These natural advantages are such that power rates for industry could compare most favorably with those of any other section of the Nation.

Power developments planned herein would approximately triple the present amount of available electric energy. In addition to an enlarged industrial consumption, greatly increased use of power is planned for other commercial and domestic consumers. The electrification of rural and village homes, for example, would expand greatly the use of electrical energy.

3. *Minerals and Raw Materials.*—The abundant supplies of hard and soft woods in the eastern portion of the Valley and the large quantity of petroleum, coal, and natural gas in many sections are in themselves sufficient for a great industrial expansion of the area. In addition to refining, processing, and fabricating industries, these materials provide the basis for the great plastics and chemical industries which are likely to mean so much in the future industrial development of this Nation.

Likewise, forest and cotton products are important in the manufacture of cellulose, rayon, and plastics. New synthetic glues offer almost unlimited possibilities for the use of forest products in making plywoods for airplanes, furniture, boats, building materials, and prefabricated houses, while the waste forest products and farm products also have great commercial possibilities.

In addition, two great mineral areas are situated in the Valley. Bauxite, iron, coal, helium, carbon dioxide gas, lead, zinc, limestone, building materials, ceramic clay, glass sands, gypsum, and numerous other materials exist in commercial quantities easily accessible for manufacturing.

Agricultural products in the region offer great opportunities for manufacturing. The livestock, cotton, peanuts, sweetpotatoes, soybeans, rice, broom corn, grain sorghums, wheat, fruits, and vegetables all have commercial manufacturing possibilities.

The Valley as a whole is especially favored in both the quantity and variety of products that may serve as a basis for industrial expansion.

4. *Markets.*—The requirements of a Nation at war have created a huge market for many products that may be manufactured within the region from raw materials there. The war program has led to the development of critical materials existing within the area. Continued demand by the Nation for consumer goods may confidently be expected to afford markets for years to come.

In the postwar period the Arkansas Valley will have another great market at home. Under a program of full employment the people of the region will afford a market for large quantities of manufactured goods. The magnitude of this market is indicated by these now-existing deficiencies which will be filled when the people are fully employed and able to buy the things they need: 682,000 new houses; repairs for 600,000 other houses; 1,217,000 sanitary water systems, including bathrooms, septic tanks, pumps and plumbing; an additional $50,000,000 worth of clothes annually; 790,000 cook stoves, refrigerators, washing machines, sewing machines, sets of furniture, sets of dishes, sets of cooking utensils, and other similar articles. Extensive needs are evident also in farm equipment, machinery, and electrical fixtures.

Planned Industrial Expansion

Six areas in the Valley are properly located for industrial expansion with reference to raw materials,

labor, and potential or existing power and transportation facilities.

Area No. 1, in Colorado, New Mexico, and Kansas, centering around the upper Arkansas River, takes advantage of the coal, lead, and other minerals of that area, and of the great supply of agricultural products in the irrigated valleys. Water is limited for industrial development and only carefully selected industries are suggested here. Some labor will be available as a result of the reorganization of farm units and the periodic unemployment in the mining villages.

With additional electrical power made possible by a transmountain diversion of water, and with an expansion of steam-generated power, electrical furnaces could be provided for making alloy steel. Such a development could lead to an increase in machinery manufacturing.

Enterprises which might be developed and expanded here are: canning, vegetable seed, dairy products, meat packing, furniture, cement, ceramic products, drills, machine-shop products, pipe, steel bars, flat steel, stoves, structural and ornamental steel products, mining machinery, farm machinery, novelties, ornaments, chemicals, bathroom and kitchen fixtures, smelting, and glass.

Expansion of manufacturing might in time afford full employment to 8,000 additional workers in this area.

Area No. 2, in the Texas Panhandle and extending north through the Oklahoma Panhandle into southwestern Kansas, is one of the richest natural gas areas in the Nation, and can draw upon petroleum, natural gas, livestock and grain products. Extreme care must be exercised in planning industrial expansion in this area because of water deficiencies. Industries using great quantities of water would deprive agriculture and domestic consumers of necessary water. Except for displaced agriculturists, labor would not be abundant in this area.

Industries capable of being developed and expanded are: dairy products, meat packing, high-octane gasoline, alcohol, cereals, leather products, ceramic products, wallboard and plaster, machine-shop products. Full-time employment in manufacturing for 7,000 additional workers might be created in the decade following the war.

Area No. 3, in Central Oklahoma, contains petroleum, natural gas, building materials, glass sands, clays, limestone, wheat, grain sorghums, cotton, peanuts, livestock, broom corn, and numerous minor crops, all of which can be utilized for industrial expansion. Moreover, large numbers of people in this area are underemployed and sorely in need of additional work.

The following include important possibilities for industrial expansion: Cereals, cheese, feeds, flour, meat packing, oleomargarine, salad dressing, shortening, apparel, furniture, alcohol, high-octane gasoline, paint, soap, synthetic rubber, shoes, asphalt roofing, brick, cement, glass, mineral wool, tile, foundry products, machine-shop products, tableware, farm machinery, batteries, airplanes and airplane equipment, rubber products. Employment of an additional 41,000 workers is recommended as a post-war goal.

Area No. 4, in eastern Oklahoma and western Arkansas, contains coal, petroleum, limestone, lead, zinc, natural gas, mercury, manganese, and slate in abundance. Agricultural products are cotton, grain, peanuts, hardwoods and softwoods, fruits, and vegetables. This area likewise has an oversupply of labor which exerts a great pressure on the land that should be relieved. Hydroelectric power and steam power can readily be obtained. Water is plentiful.

Products which might contribute to further industrialization in this area are: canning, dairy products, meat packing, quick-frozen foods, textiles, apparel, furniture, gliders, plywoods, radio cabinets and assembly, wooden boxes, paper boxes, enameled products, zinc smelting, fertilizers, grain alcohol, nylon, plastic powders, resins, synthetic rubber, coal tar products, coke, small leather goods, brick, fibre glass, glass, glass containers and blocks, spun glass, wallboard, bolts and nuts, wire, mining machinery and tools, oil refining and drilling equipment, auto tires and tubes. This area, along with Areas 5 and 6, has great advantages in chemical and plastic industries. The above industries might account for an increase in employment of 46,000 above the 1939 level.

Area No. 5, situated in two belts in the Ozark-Ouachita Highlands, has hydroelectric power and steam power potentialities, as well as lead, zinc, iron, and many other minerals. A variety of both hard and soft woods and agricultural products are available for use. Here, too, a great mass of people are underemployed and must find additional work opportunities.

Industries which might be developed and expanded in this area are: Brandy, canning, dairy products, dehydrated products, meat packing, poultry processing, quick-frozen foods, wines, awnings, cotton textiles, apparel, sheets, furniture, veneers, windows and doors, printing, fertilizers, lime, belts, luggage, shoes, brick, cement, tile, foundry products, machine-shop products, stoves, structural steel, galvanized products, electrical appliances, boats. In this area 29,000 additional workers might be provided with jobs.

Area No. 6 is located in the Forested Coastal Plains of Arkansas, Louisiana, and Texas. Natural gas and petroleum, and timber, cotton and other agricultural products, are all available in great quantities. Approximately one-half of the farm workers of this area should be employed in industry.

Enterprises which might be developed and expanded

in this area are: Beer, feeds, meat packing, oleomargine, syrups, starch, cotton yarn, rayon, cotton goods, apparel, mattresses, sheets, furniture, matches, plywoods, veneers, paper and paper products, lithographing, printing, ammonia, drugs, fertilizer, lineoleum, raw and fabricated plastics, sulphuric acid, synthetic rubber, petroleum refining, shoes, brick and tile, cement, glass, air conditioning equipment, bathroom equipment, foundry products, iron and steel products, iron smelting, stoves, aluminum and its products, tableware, electrical appliances, electrical wiring and motors, fluorescent light bulbs, auto tires, tractors, rubber products. Approximately 59,000 additional workers might be employed in industry here in the post-war decade.

Altogether new manufacturing developments in these six areas might lead to the employment of 230,000 workers. This would bring the total thus employed in the Valley to 460,000 people.

Future Manufacturing Industry

An expansion of basic processing of raw materials has occurred in the Arkansas Valley as a part of the Nation's program to increase war production. In order to secure the further expansion of manufacturing, to supply the peacetime needs of the people, and to utilize the resources and the labor of the region, a concerted effort by the people of the Valley is required. Insofar as possible, private industry and community effort should be relied upon to bring about this expansion; in certain fields, local, State, and Federal assistance may be needed.

Education program.—In this plan, great reliance is being placed upon the people of the Valley. For too long they have lived in the hope that someone from outside the area would establish industries here to develop the local resources. The people of the Valley should be aroused to a real appreciation of the possibilities for a better life which are latent in their resources of labor, raw materials, and power. They should be brought to a realization also of the fact that they themselves form the logical group which should carry out the needed developments. All of this can best be accomplished through a program of education which points out the advantages of the area and ways in which the enterprise of the people living there can create for it its proper place in the life of the Nation.

Expansion of power.—A primary requirement for the expansion of some industries is an ample supply of power at favorable rates. Through this plan the present output of electric energy would be tripled. The balanced development of the hydroelectric power possibilities and the steam-electric power from the use of the low-cost fuels of the Valley can be had through a Valley development program in which the Federal and State Governments cooperate with private industry to make available low-cost power for industrial and domestic use.

Capital for industrial expansion.—When the people of the Valley are vitally interested in developing the resources of the Valley it is believed that much of the "venture" capital required to establish new industries will come from them. Those who have participated in the development of the oil, natural gas, timber, and other raw materials may cooperate in helping finance the expansion of industry so vital to the area. Many of the industries proposed would use established processes and methods with risks fairly well understood. Such plants can be financed either privately or through cooperative community organizations.

In the case of new processes or methods, a favorable report from the "Research Organization" suggested below would assist the management in securing proper financing of the venture. In the expansion of industry for war production the Federal Government has assisted in the expansion of facilities operated by private enterprise. While specific recommendations are not made as to the methods it is believed that new methods of financing could be developed to assure capital for publicly desirable industrial development of resources.

Conversion of existing war industries.—The industrialization of the Arkansas Valley depends in part upon the successful conversion of war production plants to peacetime production. At present approximately 150,000 persons are engaged in war industries and when peak production is reached the number may be over 250,000. Roughly one-half of the workers in war industries are in plants having strictly war functions.

A number of plants are producing goods required in time of peace and thus will not require extensive conversion. Examples include aluminum, zinc, steel, aviation gasoline, aircraft, synthetic rubber, prefabricated housing, and others. It may be that aircraft-productive capacity will far exceed market requirements and considerable contraction may be necessary.

The difficult problem will come in connection with shell loading, powder, explosives, and ammonia plants. Here conversion will be extremely difficult and costly. Perhaps the best that can be hoped is that some of them may be used as stand-by munitions plants in case of future need. Shell-loading plants possibly could be converted to the production of small machines, equipment, tools, kitchenware, stamped and pressed goods, motors, and other products. Powder, explosives, and ammonia plants possibly could be converted to the production of certain fertilizers, chemicals, and plastics.

For any industry, conversion will be extremely costly both in time and money. It will undoubtedly require plant additions, retooling, additional machinery and equipment, different labor skills, and so on. If con-

version is to be attempted, it is imperative that advance plans be made before the war ends. Moreover it is indispensable that work begin immediately on the above problem.

Research in manufacturing processes.—As a part of the program for the development of the Arksansas Valley a coordinated research effort should be made. Cooperating in this undertaking would be various state institutions, industries, and agencies of the Federal Government. At the moment, industrial research is confined to that being done only in piece-meal fashion by isolated institutions.

Such a research organization would center its attention upon the development of practical processes and methods for the fabrication and distribution of the raw materials in the Valley. As an example, anticipating the extensive building program required for the construction of the 682,000 new homes that are needed, plans should be made for the mass production from local materials of low-cost homes equipped with efficient air-conditioning, heating, and water systems, electricity, insulated walls, and other features of modern housing. Similar approaches should be made to the production of furniture, equipment, and tools suitable to the needs of the area.

Much could be done in coordinating the research activities of existing institutions and private industries in the area by means of a coordinating agency. This research organization would cooperate in the development of new methods of using wood, minerals, building materials, and other products, and in establishing pilot plants to demonstrate and test these methods. Out of this would come the development of private companies or cooperatives to produce goods commercially.

Such research is required if the small industrialist is to continue to participate in the development of the Nation, since he does not have either the capital or the personnel to do this work for himself.

Services and Service Industries

When 230,000 new workers are engaged in manufacturing pursuits, a much larger number must be employed in services and service industries.

It has been estimated that the anticipated expansion of the various service industries made necessary by the shifts in agriculture and the increase in manufacturing would create the following new jobs: mining, 15,200; construction, 128,600; wholesale and retail trade, 164,800; transportation, communications and other public utilities, 141,900; finance, insurance, and real estate, 34,200; business and repair services, 28,200; personal services, 87,500; amusement, recreation and related services, 24,200; professional and related services, 102,700; public service, 49,300; miscellaneous services, 30,400. This makes a total of 807,000 new jobs in the service field, the amount of employment believed necessary to maintain a desirable balance of employment in agriculture, service industries, and manufacturing.

Other Adjustments

In addition to the shifts from agriculture to industrial employment required in this plan, certain other changes are also necessary to the rehabilitation of the Valley economy.

Health

In spite of efforts made by the medical profession and by various private and government agencies, medical care and hospitalization are quite inadequate in the Valley, especially in the rural areas. In the eastern half of the Valley, malaria is prevalent in the lowlands, and hookworm, malnutrition, dysentery, and typhoid fever are present to an alarming degree.

The Arkansas Valley is largely an agricultural region. In the west, farm population for the most part is sparsely scattered on farms and ranches, requiring either doctor or patient to travel great distances for medical care. In the eastern half of the Valley the low economic status of many families makes adequate medical care unattainable. Throughout the Valley the majority of the doctors are concentrated in the larger towns and cities. Many of the doctors in the rural areas are more or less inactive because of their age. The situation with regard to dental services is equally inadequate. A lack of hospital and diagnostic facilities in rural areas tends to prevent the location of young doctors in these areas.

In rural areas one physician should be available for every three to four hundred families, so located as to be reasonably accessible to the families at all times. In addition to this, the services of specialists should be available in centers for consultation and special care. Hospital facilities should be provided at the rate of one bed for approximately each four hundred persons, with the essential drugs prescribed by the physicians conveniently available. Provision should be made for adequate dental services with the use of dental trailer clinics, especially in rural areas where the population is scattered and local dentists are not available. Local full-time public health services should be provided in every county. In order to prevent disease in rural areas each farm home should be made sanitary by screening, protection of the water supply from contamination, and sanitary disposal of human waste.

There are not nearly enough hospitals in the area to serve the people. This is especially true in the farm and rural-nonfarm communities. Approximately 300 small 30-bed hospitals would be required to bring reasonable hospital facilities to the Valley. In each of these hospitals doctors could organize and operate clinics to provide complete medical service to the surrounding area.

Many of the main streams of the Valley are polluted, and a pollution control program should be agreed upon and put into operation. The sanitary engineers of the various States have cooperated in classifying the streams and suggesting places requiring treatment of sewage and regulation of industrial wastes. These rough classifications are shown in fig. 9. In proceeding with this program, additional research or survey studies are required and specific legislation is necessary in many of the States.

Anticipating a great need for hospitalization for those disabled in the war, it is possible that a system of community hospitals can now be established to serve both disabled soldiers and the civilian population, and to serve also as clinical centers. Through a joint planning approach, the location and method of operation of these centers can be determined, and the hospitals can be built with funds supplied by community, State, and Federal governments.

In seeking adequate medical care, a more exhaustive study should be made to determine the health needs in each area in the Valley. All professional groups and agencies should be consulted and their full cooperation solicited. Such cooperation can assure the development of efficient techniques of practice. While the major program for medical care centers about the raising of the economic status through full employment of the people of the Valley so that they may pay for their medical care, it is recognized that this cannot be immediately and completely effected and that additional public support must be given the Public Health Service and medical profession if adequate medical care is to be made available.

Education

When the Arkansas Valley moves into a program of full employment, very profound changes will be made in the everyday life of all the people. It is important to the success of the program that people understand what it will mean in terms of their use of resources, the relation of their jobs to the total developments and their full measure of responsibility in effecting this great change.

Educational institutions, public schools, universities, colleges, and various public and private agencies must coordinate their efforts in order to assist people to make necessary changes in both attitudes and performance. They must work with the people in each community in the development of plans to fit the community into the new path of operation in the Valley.

Students in the schools must become aware of world, national, regional, State and community affairs, problems, and relationships; and school leaders must assume the responsibility of stimulating an intelligent, understanding participation in community affairs by all of the people. Also, school leaders must themselves participate in planning and carrying out community projects, in encouraging conservation and proper use of resources, and in bringing about the participation of all of the people of the community in effecting well-rounded community development. Discussion groups, forums, and planning committees in which workers at all levels participate are required to create an understanding by the people of the possibilities for regional growth.

Approximately 780,000 young people in the region are between 15 and 20 years of age. Some 641,000 of these boys and girls are not attending school. Strenuous efforts should be made not only to keep them in school but also to encourage their active participation in programs designed to promote community welfare. More emphasis should be placed by educators on specific training in trades and in the development of community-wide projects.

Through regular channels in each State, appeals should be made to teachers and school officials to participate in community, State, and regional planning functions. Educational material on regional development should be distributed, and community plans and experiences should be exchanged.

Federal aid for school training and camp operation should match State and community contributions toward this program for extended education and community development.

The concept of full and efficient employment of the people necessitates in turn new concepts of work training, use of equipment and tools, housing, medical care, and other basic factors in modern life. In a balanced national economy, each worker's importance as a consumer is equal to his importance as a producer. Provision for adequate diets for workers in industry and agriculture assures markets for farm produce. Similarly, adequate purchasing power of farmers and industrial workers should assure markets for industrial goods. Furthering acceptance by the people of this general concept of an economy of abundance in place of a scarcity economy is largely the job of educators.

Recreation

Full and efficient employment of the people will create a great increase in the use of recreational facilities. Aspects of recreational development requiring public consideration are coordination of regional, State, and area facilities, and commercial development and community improvement designed to meet local recreational needs.

The abundant recreational features of the Ozark-Ouachita Highlands and the hills and mountains of southern Oklahoma are not as accessible to tourists as they should be. To remedy this, a parkway has been

suggested which, beginning in Missouri, would sweep down through Arkansas into southern Oklahoma. Properly integrated with State plans for recreational development, this parkway would increase the revenue of the area far beyond the cost of its construction. As a part of a national system of parkways this Ozark one would connect with the Mississippi parkway and eventually connect with others developed in the Rocky Mountains in the West.

In integrating recreational plans for the Valley, full recognition of the needs for park and recreational development in all States could be assured through their participation in a regional committee set up for this purpose. Among the aims of such a committee should be the establishment of uniform licenses and requirements for lodges, camps, and other commercial recreation enterprises.

In the development of all dams for flood control, power, water supply, and of conservation and stream-improvement work, full consideration should be given to recreational possibilities. For example, the shoreline along all artificial lakes, and land along each stream having notable recreational possibilities, should be publicly owned and should be developed in accord with the plans of State and regional recreation committees. A proposal for the development of parks, dams, parkways, and other recreational features is indicated on fig. 13.

The commercial aspects of recreational development in the Valley are expected to add materially to its income and to contribute a great deal toward the goal of full employment.

In addition to promoting commercial recreational developments, a much greater emphasis must be placed upon community recreational facilities. Swimming, boating, and bathing should be located within 50 miles of all the people. Construction of facilities for these water sports should be largely a community responsibility, planned and carried out with the help of youth camps. Also numerous attractive parks can and should be provided within the area.

Transportation

The Valley is now well served by both railroads and highways, and it is extremely likely that this situation will continue. In addition, a very great expansion in air transport is foreseen. This development will involve a considerable increase in the number of airports and in the development of feeder lines for mail and cargo delivery to communities throughout the area.

Specific problems of communities and areas will doubtless necessitate many local modifications and adaptations of highway, railroad, air and water transportation facilities as new developments occur in the region.

A program for the equalization of freight rates within the region with those of other regions is essential for the proposed industrial development. The Committee of Governors in the Southern States and the Tennessee Valley Authority are now working with the Interstate Commerce Commission to secure an adjustment and equalization of freight rates of the South with those of other sections of the Nation.

As industry increases in the area, the pressure for more transportation facilities at cheaper rates will increase; this in turn may make imperative the development of all possible water transportation in the lower Valley. Study of transportation possibilities on the streams of the Valley show that, in view of present freight rates, the savings in transportation costs by providing 9-foot channels on the Arkansas River to Tulsa, Oklahoma, on the Red River to Shreveport, Louisiana, and on the Ouachita River to Felsenthal, Arkansas, would approximate the costs involved. These possible developments are indicated in figure 7. In all cases involving shipment to factories of a large amount of raw materials, full advantage should be taken of cheap transportation costs by the development of navigation on the streams indicated.

Careful study should be devoted to the possibility of a large postwar expansion of air transportation for passengers and express. The desirability of utilizing the great fleets of planes likely to be available after the war, plus the large capacity for the manufacture of airplanes, make such an expanded use almost inevitable.

The interstate barriers against free movement of trucks in interstate commerce have been modified because of the war. Full use of such truck transportation after the war should be permitted in the public interest for more convenient or economical transportation.

Urban Communities

If the foregoing economic adjustments are carried out to provide continuing full employment and higher standards of living in the Valley, it will be necessary for the cities, towns, and rural communities to prepare themselves for full participation in this new life.

In the next 10 years, the nonfarm communities in the area may increase by about 1,834,000 persons, or nearly 45 percent, largely as a result of the shift of workers from agriculture into other pursuits.. Most of the established cities and towns will increase in population, and new ones will spring up around new industries.

Most of the cities within the Valley are comparatively young and have not developed unhealthy conditions to the extent encountered in cities located in certain other sections of the country settled at much earlier periods of our history than was the Valley. That does not mean, however, that they do not have incipient ills in the form of inadequate street patterns, premature

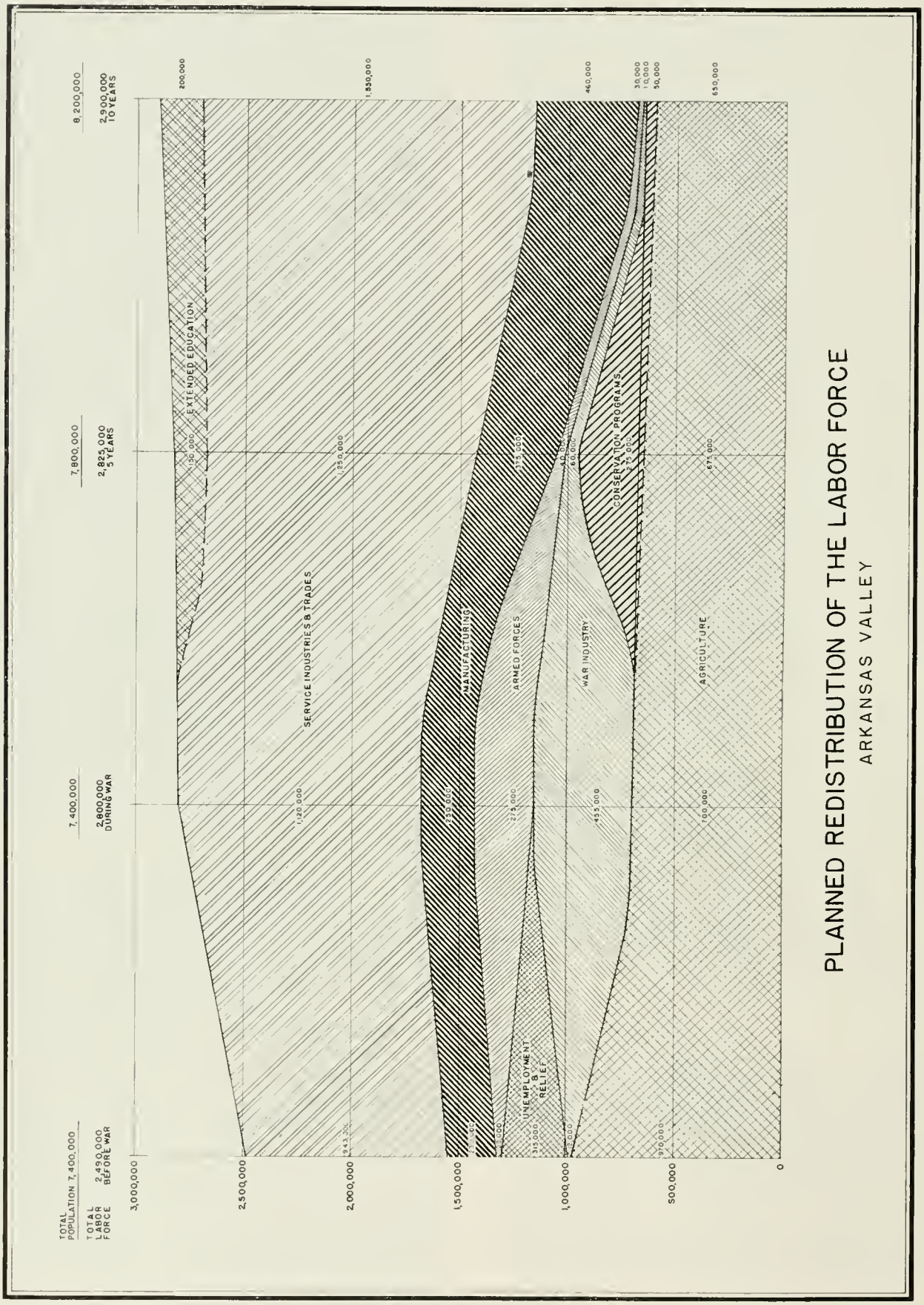
PLANNED REDISTRIBUTION OF THE LABOR FORCE
ARKANSAS VALLEY
TOTAL POPULATION 7,400,000
TOTAL LABOR FORCE 2,490,000 BEFORE WAR
7,400,000
2,800,000 DURING WAR
7,800,000
2,825,000 5 YEARS
8,200,000
2,900,000 10 YEARS
3,000,000
2,500,000
2,000,000
1,500,000
1,000,000
500,000
0
EXTENDED EDUCATION
130,000
200,000
1,850,000
SERVICE INDUSTRIES & TRADES
1,120,000
1,250,000
MANUFACTURING
230,000
275,000
ARMED FORCES
275,000
UNEMPLOYMENT & RELIEF
315,000
WAR INDUSTRY
435,000
460,000
CONSERVATION PROGRAMS
30,000
10,000
30,000
AGRICULTURE
970,000
700,000
670,000
550,000

Figure 1.

subdivisions, blighted property, fringe slums, confused railroad terminals, substandard housing, lack of sanitation, and the like. Immediate and determined efforts to correct these maladjustments must be undertaken if the various communities are to offer anything worthwhile toward the greater development of the region.

Strictly urban communities are expected to add approximately 1,000,000 people to their population in the next 10 years by movement from rural areas and by natural increase. This great shift is already under way and the establishment of war industries and camps in many of the cities has shown the cities to be generally unprepared for such rapid expansion. Congestion, lack of housing, and overcrowding of restaurants and hotels embarrass the war program and also hold a continual threat to the health and general welfare of the people.

Full employment of the people at reasonable wages will result in a huge increase in general business. Food, clothing, furniture, service, and recreational demands will practically double. Better homes in better communities and neighborhoods will be sought.

Redistribution of the Labor Force

Total Labor Force

At the beginning of the war there were 2,400,000 workers in the Valley. About 970,000 of these were employed in agriculture, 230,000 in manufacturing, and 943,000 in the miscellaneous group of trades called services and service industries. This group includes those working in mining, construction, transportation, wholesale and retail distribution of goods, machine shops, garages, and various professions, including education and similar pursuits. (See Fig. 1.)

Approximately 20,000 were in the armed forces and an estimated 12,000 were in pre-war defense work. The number of those unemployed or working on relief programs was estimated to total 315,000. Since the last census there has been an exchange of workers with other areas; some have left this region and some outsiders have been employed in war work here. No statistical information is available on the exact balance at this time.

Under the pressure of the war program, the number of workers will be increased by about 310,000, aside from the normal annual natural increase. At the height of the war program the Valley will have a labor force of 2,800,000. Two hundred thousand of these will probably be women workers and 110,000 will be additional male workers not normally in the labor force. An anticipated increase in population of 1 percent per year indicates a probable total of 7,800,000 people in the region within the coming 5 years. This is predicated on the assumption that none of these people will migrate out of the area. The expected labor force at the end of 5 years is 2,825,000. Of the 310,000 additional workers who entered the labor force during the war effort, 100,000 will have been dropped. These will be mostly women.

In 10 years the population is expected to reach 8,200,000, with 2,900,000 people in the labor force. Another 50,000 of the 310,000 increase that came during the war will have been dropped.

Agriculture

To achieve full and efficient employment in the Valley, the total number of workers currently employed in agriculture, 970,000, should in the next 10 years be reduced to 650,000. (See Fig. 2.) Properly equipped, this number of workers could operate the farms, conserve the soil, and earn sufficient incomes to enjoy the level of living anticipated in this report for rural areas.

Manufacturing

Manufacturing of raw materials into finished goods has been extremely limited in this area. Only 230,000 people were employed in this work in 1940. Immediately at the close of hostilities, war industries in the Valley should in part be shifted to production of consumer goods. At the end of 5 years, 375,000 workers could be employed in manufacturing, and by the end of the 10-year period 460,000 could be working in this field, if industrial possibilities are effectively developed.

War Industries

It is estimated that pre-war defense work employed 12,000 people in the development of airports and in other special defense efforts. Actual war industries employing over 250,000 workers in manufacturing or processing of war materials are in operation or under construction at the present time. Housing, increased transportation, communications, governmental war organizations and other undertakings are expected to swell this total to 455,000. This number will taper off after the war, the industries insofar as possible being transformed into peacetime goods industries, with some continuing production of actual war goods.

The Unemployed and Relief Workers

Approximately 460,000 persons were classified as unemployed, on relief, or on Federal work projects in 1940. Elimination of duplication in agriculture and other services reduces this number to 315,000. It is contemplated that all able-bodied workers in this group will be absorbed at the height of the war program.

The Armed Forces

Approximately 20,000 workers from the Valley were in the armed forces before the war. It is expected that

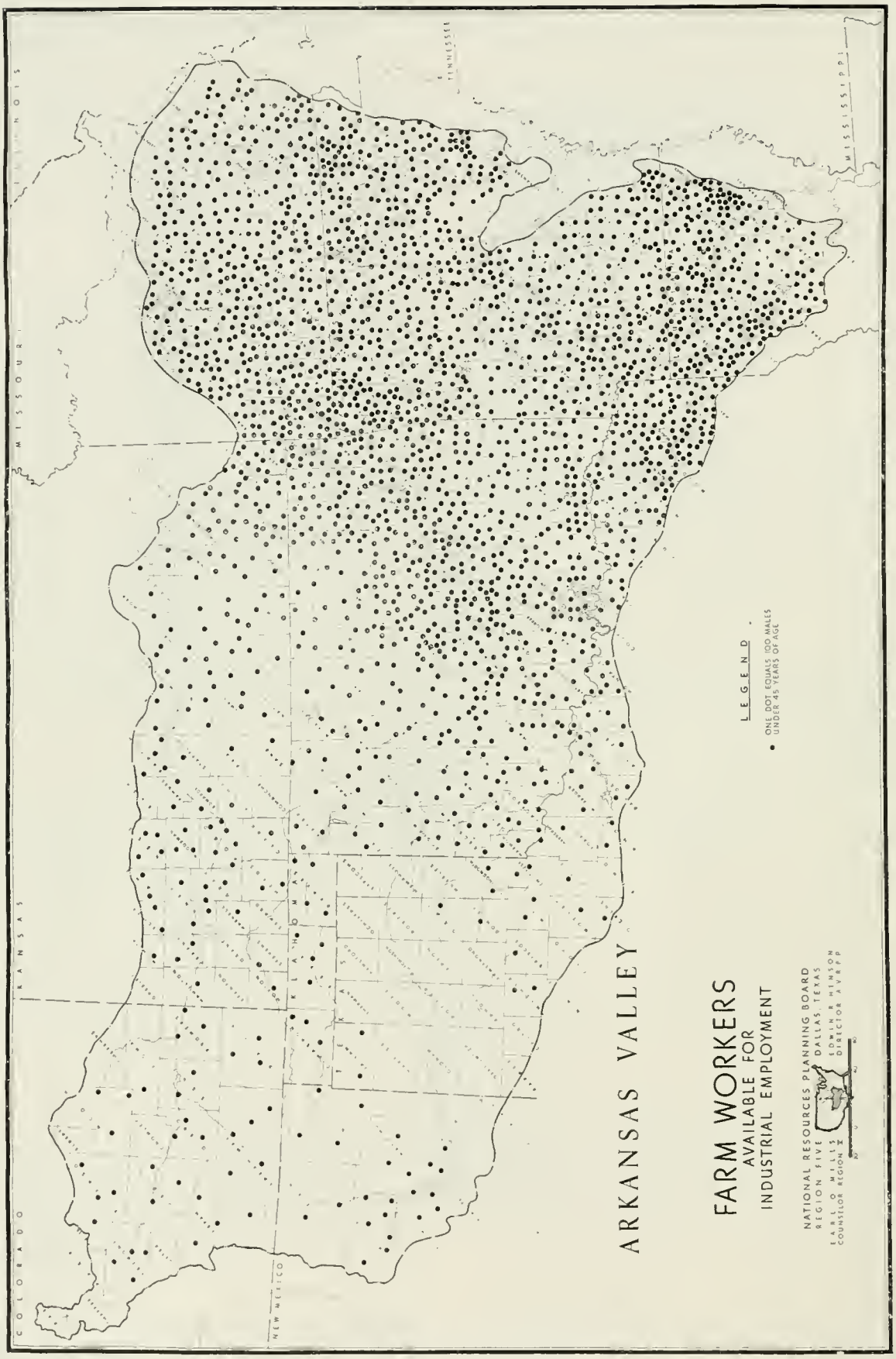
FARM WORKERS
AVAILABLE FOR
INDUSTRIAL EMPLOYMENT
ARKANSAS VALLEY
LEGEND
ONE DOT EQUALS 100 MALES UNDER 45 YEARS OF AGE
NATIONAL RESOURCES PLANNING BOARD
REGION FIVE DALLAS, TEXAS
EARL O MILLS COUNSELOR REGION V
EDWIN R HINTON DIRECTOR AVRPP
COLORADO
KANSAS
MISSOURI
ILLINOIS
TENNESSEE
MISSISSIPPI
NEW MEXICO
OKLAHOMA
TEXAS

FIGURE 2.

approximately 450,000 will be so classified at the height of the war program, assuming an Army of 7,500,000. Anticipating a somewhat larger standing army, probably 40,000 would be in the military forces at the end of 5 years, and 30,000 at the end of the 10-year period.

Service Industries

Beginning with 943,000 employed in this field, the number would be expected to increase to 1,120,000 people at the height of the war program. The specific occupation of many of these workers would shift during the war. A very significant decrease of those working in the automobile service industry, as well as in professional services and wholesale and retail trades, is contemplated. There would be a great wartime increase in transportation, communication, and governmental activities related to the war program. At the end of the 5-year period a further increase in this field is contemplated to balance more nearly the increase in manufacturing: by the end of the 10-year period the number of workers in manufacturing, services, and agriculture would be as shown in figure 2.

Conservation and Development Work

Immediately at the close of the war it is anticipated that soldiers will be returning from the army camps in large numbers. Industrial plants throughout the Valley making strictly wartime goods will taper off and release many workers so that through the period approaching the end of the war and pending the conversion of war plants to peacetime goods production it is anticipated that a good many workers will be available for employment. Although contemplating that expansion of private industries, services, and service industries will eventually absorb practically all of this labor, it is essential that economically sound public improvement programs be planned in detail and ready for construction in time to give employment to labor as this labor is released from its wartime work.

There is an abundance of sound developments that must be carried out in the Valley so that in the interim while industry is changing from war production to production of peacetime goods no persons need be unemployed who are willing to work. It is extremely important that work opportunities be planned for this transition period so that there will be the minimum loss of purchasing power on the part of workers, no great rush back to the land for subsistence living, and no feeling developing on the part of returning soldiers and workmen that their services are no longer needed. This can be done with foresight and planning. Economically sound developmental programs can be had in this area by careful planning now. Private industry, Federal, State, and local governments are now giving consideration to this problem.

Great reliance must be placed upon private enterprise for the bulk of employment even during this transition period. This employment may well come in the actual construction and conversion of industrial plants and in the building of homes. Use of reserves of capital to construct homes immediately at the close of the war offers a great opportunity for employment.

State, county, and city governments are now planning repairs and new construction in the form of public improvements on which work can be initiated immediately. A preliminary estimate of the volume of such improvements in the Valley, based on careful studies in only a few communities, would indicate something over $400,000,000 worth of capital improvements needed in the region. In addition, State highway departments have extensive plans for road improvement and construction.

The economically justifiable projects in the fields of irrigation, flood control, pollution control, water supply, recreation, and power development suggested in this plan would require more than $500,000,000. It is not contemplated that these projects could or should all be initiated at once, but over the years as required, these projects can be used in connection with expanding employment in private enterprise to maintain a reasonable degree of full employment.

Land conservation and forest management are vital to this region and to the Nation. A very great amount of work would be necessary to prevent further deterioration of our land and forest resources. Estimates have indicated that approximately 1,800,000 man years of labor will be required to check erosion and deterioration of land resources. This great amount of work can more efficiently be done by the farmers on the land and would be a part of a program to maintain incomes in rural areas.

In addition to those absorbed in private industry during the transition from war to peacetime production, it is estimated that employment must be found for 275,000 workers in making civic and other public improvements, in conservation work, and the development of resources. Such work should be done insofar as possible by private contract—contracts let and work begun immediately with the closing of the war. Employment in these fields would be expected to taper off and private enterprise should absorb practically all workers by the end of a 10-year period.

Education

Under the proposed plan for the Valley, immediately at the close of the war all of the returning soldiers who desired to continue in school would have an opportunity to do so. They would enter regular educational institutions or camps designed to carry out community improvements in combination with an

educational program for training workers for industrial and agricultural work.

Supplementing this group would be youths between the ages of 14 and 18 years, who have heretofore dropped out of school and sought work in competition with adults. It is estimated that 150,000 young people could take part in this educational program within 5 years. Increasing participation would swell this number to 200,000 in 10 years.

Summary

If the plan is successful, the labor force would be fully employed at the end of 10 years. There would be 650,000 workers in agriculture doing some additional work on conservation, 460,000 in basic manufacturing industries, 10,000 in the production of war materials and maintenance, 30,000 in the Army, and 1,550,000 in service industries, with 200,000 in continued education and community development work.

Not all that needs to be done can be done in these 10 years. But much progress could be made in the general endeavor to make full use of the waters of the rivers, protect the soil, develop power, build and electrify homes, construct sanitary units, and carry out many other needed projects. Better medical care would assure a sounder, more capable group of workers. A functional educational program would engender understanding participation in regional and national efforts. The majority of the people will have an acceptable level of living and will be ready to make even greater progress in the next decade.

Summing up, the specific things which must be done in the Arkansas Valley relate to:

1. *Enlargement of farms.*—Small, inadequate farms should be combined into efficient family-size enterprises: plans should be formulated for conservation of the soil; and livestock, machinery, housing, sanitation, and other factors necessary for efficient operation should be made available to farmers.

2. *Employment.*—New jobs should be provided for 1,135,000 workers in the next 10 years. This should be done by:

(a) Stimulating the establishment of new manufacturing industries which would employ 230,000 workers;

(b) Expanding service industries to employ an additional 807,000 workers.

3. *Communities.*—Programs for communities should include:

(a) Development of rural industrial communities for rural nonfarm workers of sufficient size and number to accommodate an increase in this group of 800,000 people during the next 25 years;

(b) Development of well-planned urban communities to serve workers in new industrial centers, and extension of existing communities to accommodate one million additional people in the next 15 to 30 years;

(c) The re-planning of existing cities and towns to eliminate slums, substandard housing, traffic congestion, and duplication of services; and to provide adequate school facilities, rapid transportation facilities, protected residential areas, industrial areas, and parking space.

4. *Power.*—Electrical power facilities in the region should be expanded to supply the 21 billion kw.-hr. of energy required for relatively full development of the region. This should be done by:

(a) Constructing dams and installing generating equipment for hydropower development;

(b) Expanding present steam-electric generating plants and constructing new ones;

(c) Providing electricity to 385,000 farm homes through the construction of new rural distribution lines and additional transmission and generating facilities.

5. *Industrial research.*—A research and experimental program should be established to develop processes and build and operate pilot processing and fabricating plants for the demonstration of new uses of raw materials produced in the area.

6. *Housing.*—Some 682,000 new houses should be built; major repairs should be made on 300,000, and minor improvements on 235,000. Industrial development to make materials for use in building new houses will also be necessary.

7. *Water systems.*—Processes should be designed and plants constructed to produce 1,200,000 complete sanitary water systems in rural and rural nonfarm homes, consisting of sanitary wells, pumps, pressure tanks, bathroom fixtures, sinks, pipes, and sewage disposal systems.

8. *Reforestation.*—Approximately 13,400,000 acres of land now in crops or poorly managed forest use should be brought under good forest management in the Ozark-Ouachita Highlands, Forested Coastal Plains, and Cross Timbers in order to check further loss of productivity and to shift these lands to a better use; forest improvement measures should be carried out on these lands as well as on the other 26 million acres in producing commercial forests.

9. *Re-grassing.*—About 4,000,000 acres of land in the western half of the area should be purchased by public agencies, local, State, or Federal, and restored to grass cover in order to check continuous disastrous wind erosion.

10. *Soil conservation.*—Complete conservation measures should be put into effect on all lands to prevent further erosion and build back the natural productivity of the soil.

11. *Irrigation.*—Water should be provided for the irrigation of an additional 320,000 acres west of the 98th

meridian by construction of dams to hold all suitable surface waters that may be impounded economically.

12. *Flood control.*—Dams and levees should be constructed and necessary agricultural upstream practices should be carried out insofar as economically feasible in order to achieve a substantial reduction in the $25,000,000 annual flood loss.

13. *Shelterbelts.*—Some 25,000 miles of shelterbelt should be planted on the sandy lands of the rolling plains.

14. *Stream pollution.*—The cooperation of States, cities, and industries should be secured in reducing stream pollution to assure health, a good water supply, and favorable conditions for recreation and wildlife use.

15. *Agricultural research.*—There should be stimulation and support of increased agricultural research leading to better-balanced production and conservation of the land and to better opportunities through greater efficiency in the operation of farms.

16. *Health.*—Three hundred 30-bed hospitals should be built and equipped to function as complete medical clinics for areas not having such services.

17. *Recreation.*—Development of recreational facilities should include:

(a) Acquisition and development for public use of the shorelines of all lakes, reservoirs, and suitable streams. This would include projects in connection with construction of all flood control, irrigation, power, and water supply dams.

(b) Building of 555 town, city, and county parks and playgrounds, and 41 State and Federal recreational areas.

(c) Promotion of recreational use of the Ozark-Ouachita area by developing a system of connecting parkways and bridle paths, bicycle paths, resorts, camps, hotels, restaurants, swimming pools, and various other accommodations and services.

18. *Education.*—Developments along educational lines should be:

(a) A blending of the educational efforts of all agencies and institutions within the region to acquaint the people with its resources, its opportunities, and its needs. Education should aim toward full employment and optimum use of the Valley's resources for national welfare.

(b) Fostering of adult education programs.

(c) Maintenance in school of all young people 18 years of age or younger.

(d) Demobilization of all soldiers who have not completed their educational work directly into educational institutions or vocational training schools. All others should be demobilized directly into jobs.

(e) Provision through educational institutions of adequate training in industrial work, management, and research.

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ARKANSAS VALLEY
PEOPLE
PRESENT DISTRIBUTION
LEGEND
URBAN
RURAL
DATA FROM U.S. CENSUS, 1940

FIGURE 3.

PART III. BASIS FOR THE PLAN

The plan herein presented for the development of the Arkansas Valley is based on a series of analyses of existing conditions in the area. These analyses are in turn based largely on surveys previously made. Specialists in the various fields have drawn together pertinent information required to appraise the existing situation, to point out the difficulties and problems encountered at present, and to indicate the effect of a plan to utilize fully the available labor and resources.

THE PEOPLE

According to the 1940 census, there were 7,400,000 people in the Arkansas Valley. Most of them were white and of old American stock. However, there were 728,738 Negroes, located mostly in the Forested Coastal Plains, Ozark-Ouachita Highlands, and the Central Prairies, and 63,125 Indians, living in Oklahoma.

Population Analysis

Distribution of the People

The population is predominantly rural—43.83 percent of the people live on farms, 22.88 percent live in villages under 2,500. (See Fig. 3.) Of the 2,455,000 people living in 227 urban areas, 32 percent inhabit small towns with populations of from 2,500 to 10,000; 21 percent are in cities of from 10,000 to 25,000; 13 percent live in cities of from 25,000 to 50,000; 34 percent live in cities of over 50,000. The distribution of people in farm, rural nonfarm, and urban groups is shown in the following table, which indicates also the percentage of the population in each group in the Nation (the wide variation in distribution from the national average is of great significance in considering the problems of the Valley):

Rural and urban distribution of population in the Arkansas Valley and corresponding percentages for the United States, 1940

Class of population	Arkansas Valley		United States
	Number	Percent	Percent
Total	7,400,000	100.00	100.00
Rural farm	3,255,000	43.83	22.90
Rural nonfarm	1,690,000	22.88	20.58
Urban	2,455,000	33.29	56.52
Cities of 2,500–9,999	785,000		
Cities of 10,000–24,999	520,000		
Cities of 25,000–49,999	315,000		
Cities of 50,000 and over	835,000		

Population is sparse in the western part of the area; it becomes increasingly dense toward the east, reaching maximum density in the Central Prairies and dropping slightly in the Forested Coastal Plains and Ozark-Ouachita Highlands.

The urban population is concentrated in a belt about 150 miles wide, extending north and south across the central part of the Valley. Forty-six percent of the urban population is located there, living in 82 of the 227 cities of the region.

Age Composition of Population Groups

The high rate of natural increase in the rural population is reflected in the age composition of the population. In the rural farm population, children up to 14 years of age make up one-third of the group, as compared with 29.5 percent of the rural nonfarm group, and 24.2 percent of the urban group. Due to the high birth rate and to emigration, the rural farm population has a lower proportion in the working age group (15–64).

Forty percent of the urban population is in the 20–44 age group, as compared with 33 percent of the farm population. In the city population there is one child to one and three-fifths persons in the 20–44 age group, while in the farm population the ratio is one to one. Thus the burden of child support is much greater for the rural farm population. In the urban population, 8 percent of the people are over 64 years old, in contrast to only 6 percent of the farm population.

Rate of Increase in Population

The rate of natural increase is much higher than the population increase of the area would indicate. Large numbers of people have migrated out of the Valley. The 5,611,000 peple living in the area in 1910 reproduced at a rate which should, by 1920, have increased the population by 30 percent, or 1,683,000. In this time, however, the population of the Valley increased only 17 percent, bringing the total to 6,476,000. At least 718,000 people had left the region in that interim.

Each decade has witnessed a mounting percentage of the natural increase flow out of the Valley. From 1910 to 1920, 43.3 percent of the natural increase migrated; from 1920 to 1930, 50 percent; and from 1930 to 1940, 92.3 percent. Since 1910, the Valley has contributed at least 2,055,000 people to other areas.

Despite out-migration, the population of the Valley has increased from 5,611,000 in 1910 to 7,400,000 in 1940; however, practicaly all of this increase of 1,789,000 has taken place in the urban areas. The rural population increased only 395,000 during the last thirty

years, while the urban population increased four times as much. Most of the rural increase was in the nonfarm population. From 1930 to 1940, the farm population decreased 6.2 percent, while the rural nonfarm population increased 4 percent.

Under the present agricultural organization and practices the rural farm population has reached the saturation point. In 1940 the farm income of the region was $615,000,000. With a farm population of 3,255,000 this amounts to a gross per capita income less than $189, 27 percent below the national farm average.

The urban population increase was contributed by the rural people. In 1940, the rate of increase of the rural population was 52 percent in a generation, while the urban population, were it not replenished from other sources, would have decreased 17 percent.

Urbanization is a rough measure of industrialization. The proportion of the urban population to the total regional population is increasing at a much more rapid rate than it is in the Nation as a whole.

Nevertheless, the urbanization and industrialization of the area continue to lag far behind that of the Nation as a whole. In 1910, 40.5 percent of the population of the United States was urban, but only 19.1 percent of the Valley population was urban; in 1920, urban population in the United States totaled 51 percent while in the Valley it was 23.6 percent. In 1930, 56.1 percent of the population in the United States was urban, as compared with 30.5 percent in the Valley; in 1940, 56.52 percent of the population of United States was urban, as compared with 33.29 percent in the Valley.

The natural increase in the farm population has been forced to seek economic opportunity elsewhere. A few have located in the rural nonfarm areas, more have moved to local urban areas, but most have been forced to leave the region altogether.

On the basis of present replacement indices for the various population groups, the area will have a natural increase of 672,250 by 1950, and 1,600,000 by 1965. Providing workers in this group—of whom there will be 125,000 by 1950—with opportunities for productive jobs is a major problem, but a still greater problem will arise if these people are left in the area without such opportunities. If creatively employed in the Valley, they will add materially to its wealth and to that of the Nation.

Labor in the Valley

The number of people in the labor force totals 2,490,000 and includes 75 percent of the men and 18 percent of the women over 14 years of age. The proportion of the population in the labor force varies with the groups: 30 percent (970,000) of the rural population; 31 percent (520,000) of the rural nonfarm population; and 40 percent (1,000,000) of the urban population. The difference is due to the large proportion of children in the rural population and the greater employment opportunities in the urban areas for women.

In 1940, some 18.5 percent of the labor force (or a total of approximately 460,000 people) were unemployed or employed on emergency work. Of these, 132,500 were from urban areas, 194,000 from rural nonfarm areas, and 134,000 from farms.

In an emergency the labor force can be increased during the war period to slightly more than 2,800,000 workers. This increase would come from the addition of about 5 percent more of the male population and 7 percent of the female population. The males would have to be derived mostly from those now in school, from that small group in the census recorded as "not reported," and those now reported as "unable to work." The additional women would be drawn from the group now in school or "engaged in housework."

However, the major contribution of the area to the Nation's war production will come from the full and more effective employment of the present labor force rather than an increase in the size of that labor force. As pointed out elsewhere, there are at least 495,000 workers, nearly 20 percent of the present labor force, who can be shifted to war production without reducing the production of nonmilitary goods.

Levels of Living

Minimum Incomes Required

Numerous studies on income requirements for families have been made by the Bureau of Home Economics and by the Extension Services in the States of the area. Together with the work of other specialists, these clearly show that a family of five should have a minimum income in cash, food, or perquisites totaling $1,500 annually.

R. S. Naile and H. G. Conager, in a book entitled "Income and Consumption" (New York, Holt, 1938), indicate that a family of five requires an income of $1,485 to maintain a standard of living at the "bare subsistence level," and that the minimum for "health and efficiency" is $1,735. The Consumer Purchase studies conducted by the Bureau of Home Economics in 1934 and 1935 showed that, until families reached the $1,250–$1,500 income group, they were unable to save anything, and that even then they averaged a savings of only $14 annually. Families earning incomes under that amount ended the year with deficits.

When most efficiently budgeted, an income of $1,500 for a family of five allows $500 for food, $160 for clothing, $225 for housing, $100 for household furnishings, $50 for medical care, $140 for transportation, and $325 for recreation, education, savings, insurance, welfare, gifts, and church.

For farm families actual cash needs are not quite as

great as indicated for urban families. Three hundred dollars of the food item may be substituted by home-produced foods, and since the housing item is included with the farm, it may be omitted in the cash requirements. Work opportunities off the farm usually bring in additional income. At least half the transportation costs will be borne by operating expenses of the farm. All of this reduces the annual cash needs of farm families to $700 or $800. Such an amount of cash is approximated in gross farm incomes of $1,000. Only about 25 percent (149,653) of the farms of the Valley have incomes of that size; 492,527 families fall far below the minimum.

In rural nonfarm and urban groups this $1,500 minimum income would require an annual wage per worker of $1,200; in urban areas there are approximately 1.3 wage earners in a family of five. This wage would give the family the minimum required income.

Employment

Full employment at a wage adequate for the minimum standard of living makes many other adjustments necessary. The Nation, region, and community cannot afford to pay well for inefficient and ineffective work. The volume of produce of many small farms is not worth the payment of such an amount, and many of the jobs in the urban centers and in the rural nonfarm areas likewise do not justify it.

Under these circumstances a reorganization of the work is required so that with adequate equipment the production, or the amount of work done, will warrant this payment. Full employment at the minimum wage indicates that the Nation believes the laborer worth this much to it. Employment of workers for less reduces their capacity for consumption of the Nation's products and the Nation loses.

Above this floor of wages, competition for work or workers may prevail; below it, workers cannot be hired for private profit without sacrifice of national welfare. If the latter situation is permitted, the public will have to make up the deficiency in some form. In other words, the general public will pay dearly later—in loss of production and in inadequate institutional and medical care—for the malnutrition, improper housing, and lack of medical care forced upon workers because of low wages paid.

Besides this social cost, which cannot be measured in dollars, the actual economic cost of unemployment is great. Both consumer and capital goods needed by the Nation are not produced though they are at least partly paid for indirectly through higher prices on what is produced. We really pay for what the unemployed do not produce—goods we do not get.

Population pressure upon agricultural resources in the Valley is reflected in farm income. There are 3,225,000 people living on 646,000 farms. Over three-fourths of the farms have a gross annual income under $1,000; 57 percent earn less than $600, and 30 percent earn less than $400. This gross income figure includes the farm value of the milk, butter, eggs, vegetables, and other foods produced and consumed on the farm. On many farms production does not much exceed this food consumed by the farm family.

The Census of 1940 gives the gross income of farms in the area. There is a wide variation in portions of the Valley in income per farm, as shown in the table below. (See also Fig. 4.)

Clearly, on the basis of income, there are more people in agriculture than can be supported by the present earnings and methods of farming. The 492,527 farms which have incomes under $1,000 produce about $233,314,300 worth of goods. If they were combined so that all farms would provide the minimum income, only about one-half of them could remain in operation.

On the basis of income, the produce of Valley farms will provide an adequate level of living for 526,200 workers, or 434,000 farm families, when flood control is installed, when 320,000 additional acres are irrigated, and when farm lands are operated in accordance with good conservation methods. The agricultural labor force, now amounting to 970,000 people, contains at least 433,800 workers more than the land can or should support.

The farmers' contention that production can be maintained by a drastically reduced number of operators is

Gross income of farms by areas

Area	Number reporting	Under 400		400-599		600-1000		1000-149		Over 1500	
		Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Eastern slope	10,535	5,679	53.9	1,058	10.0	1,280	12.2	795	7.5	1,723	16.4
High plains	25,309	8,008	31.6	2,756	10.9	3,789	15.0	3,066	12.1	7,690	30.4
Rolling plains	41,862	11,837	28.3	7,156	17.1	12,952	30.9	10,924	26.1	18,993	45.4
Central prairies	45,751	9,203	20.1	3,737	8.2	6,695	14.7	6,700	14.6	19,416	42.4
Flint hills	14,415	3,745	26.0	1,889	13.1	2,923	20.3	2,134	14.8	3,724	25.8
East prairies	37,800	14,366	38.0	5,973	15.8	7,862	20.8	4,617	12.2	4,982	13.2
Cross timbers	58,827	23,307	39.7	11,144	18.9	12,574	21.4	6,139	10.4	5,663	9.6
Ozark-Ouachita	253,767	116,626	45.9	49,220	19.5	49,882	19.7	20,672	8.1	17,367	6.8
Forested coastal plains	133,919	59,622	44.5	32,103	24.0	27,136	20.3	8,635	6.4	6,413	4.8
Total	642,180	252,393	39.3	115,036	17.9	125,098	19.5	63,682	9.9	85,971	13.4

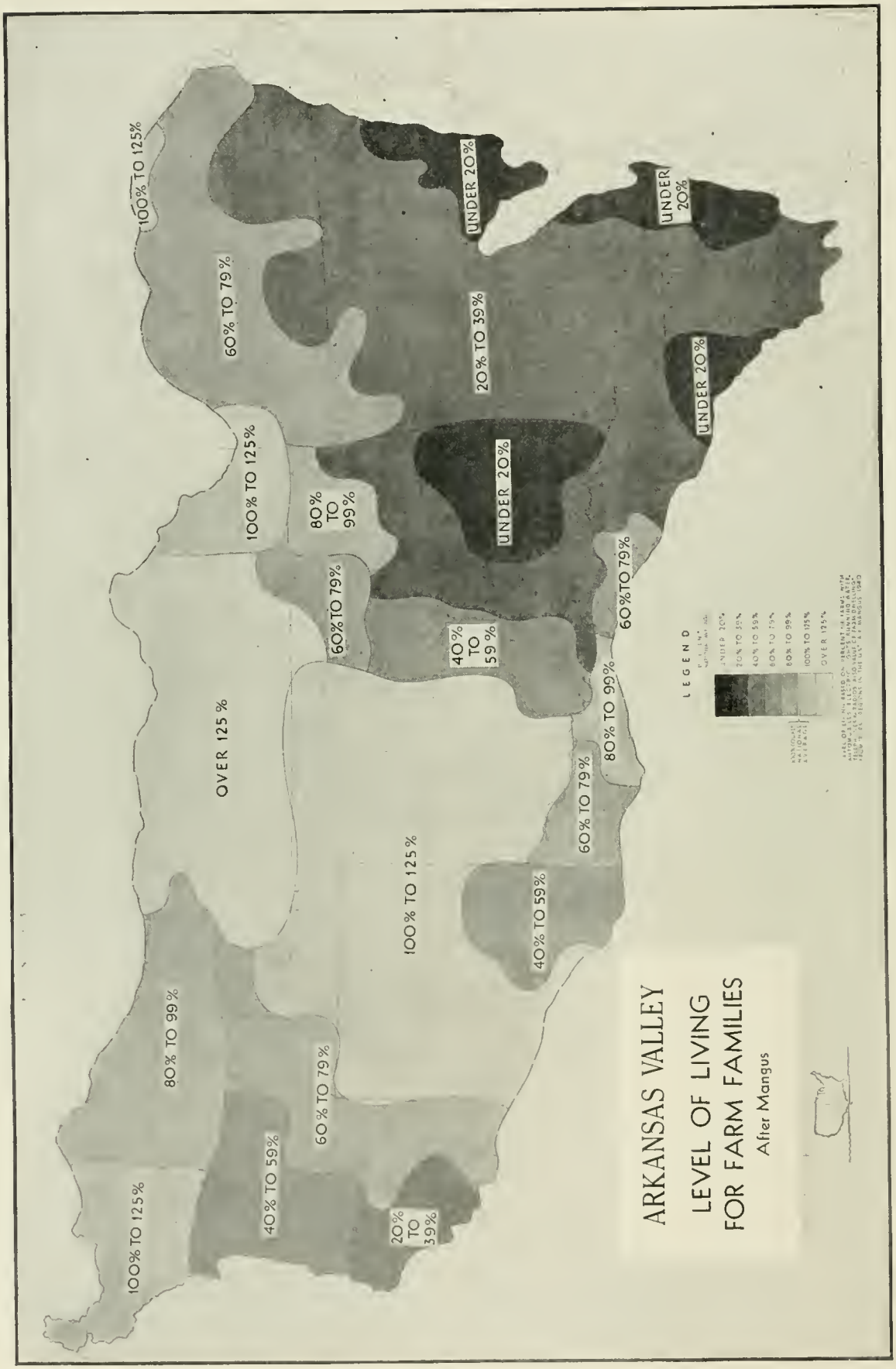
ARKANSAS VALLEY
LEVEL OF LIVING
FOR FARM FAMILIES
After Mangus
LEGEND
100% TO 125%
80% TO 99%
60% TO 79%
40% TO 59%
20% TO 39%
UNDER 20%
OVER 125%

FIGURE 4.

borne out by the census statistics. Approximately 89 percent of the agricultural produce which reaches commercial trade channels is produced on farms earning incomes of over $1,000. This region is not an exception; thus, a total of 75 percent (484,500) of the farms of the Valley raises only 11 percent of the agricultural products which enter commercial markets. In brief, 448,500 low-income farms of the area produce only one-eighth as much as the other 161,500. Thus 448,500 farm families are ineffectively employed in producing what a much smaller group could produce under proper organization.

The low incomes and underemployment of farm families have an effect on the employment and income status of the rural nonfarm population. Most of this segment of the population lives in villages and its economic function is the servicing of farm families. The low income of the farm families prevents their full use of the available services of the nonfarm population. Consequently, underemployment and low income also characterize the rural nonfarm population. In 1940, there were 1,690,000 people in the rural nonfarm population, of whom 520,000 were in the labor force; but 38 percent, or 194,000, were unemployed or engaged in emergency work. Many others were underemployed.

The Bureau of Home Economics study of income indicates that 40 percent of the rural nonfarm families in the Southern States have inadequate incomes. In the mountain and plains States, 32.7 percent of the families have inadequate incomes.

Rural nonfarm family income (white nonrelief families)

Southern States		Mountain and Plains States	
	Percent		*Percent*
Under $500	18.9	Under $500	6.6
$500–$749	13.1	$500–$749	12.0
$750–$999	11.4	$750–$999	14.1
$1,000–$1,250	10.4	$1,000–$1,250	12.5

Estimates based on unemployment reported in the 1940 Census and on income figures indicate that over 200,000 workers in the rural nonfarm population are now under-employed. Probably half of these could, if effectively employed, do the work that the entire 200,000 are now doing.

In the urban population of 2,455,000, with its labor force of 1,000,000 workers, there is similar pressure upon the employment opportunities. One hundred and thirty-four thousand people were unemployed or engaged in emergency work. Forty-five percent of the employed families had incomes under $1,000, and 18 percent earned less than $500.

Distribution of income of nonrelief urban families in the Southern region

Income level	2,500 to 25,000 population	25,000 to 100,000 population	Over 100,000 population
	Percent	*Percent*	*Percent*
Under $500	18.3	17.0	10.9
$500–$749	14.7	13.2	11.2
$750–$999	12.4	10.4	10.8
$1,000–$1,500	21.0	15.8	17.6

Based on these incomes, approximately 250,000 workers do not receive more than half the income required for the minimum level of living. Approximately one-half of these should have new, full-time jobs.

Underemployment and low income in the Valley are due to the slow growth of employment opportunities in relation to the high rate of population increase. The region has lagged behind the rest of the country in the development of industry; primarily, it has always been an agricultural area. Many years ago the agricultural resources were adequately manned, but the rate of population increase, especially in the rural areas, remained high—much higher than the increase in labor demand off the farm. This produced a pressure upon the land. The surplus population sought employment first in agriculture, then in rural nonfarm areas, then in cities within the region, then outside the region.

In agriculture, this pressure reduced the size of farms and made human labor so cheap that mechanization was retarded. In the small towns it spread out employment so thinly that incomes were forced down. In the urban areas, the labor supply always exceeded the demand. In all groups of the Valley's population, large numbers of people have always been unemployed, and still larger numbers underemployed.

Potential Markets

The volume of unmet needs for consumer goods in the area is of tremendous proportion. When given purchasing power through full employment the present market for consumer goods will be multiplied several times. The general level of living now existent indicates the extent of deficiencies which will be filled when funds are available.

Assuming that, when fully employed, people in this region will move at least to the average level of living current in the Nation, there are certain definite things they must have.

The requirements of the people for housing, food, clothing, household furnishings, sanitation, and health

have been considered in numerous surveys and studies. The Bureau of Home Economics, the Extension Service, Bureau of Agricultural Economics, and the 1940 Census have all gathered basic information in this field. This material has been included in the present survey of needs in the Valley.

1. *Need for housing and sanitation.*—There are approximately 1,850,000 houses in the area; 813,750 in the rural farm area, 422,500 in the rural nonfarm area, and 613,750 in cities. Surveys of their condition show that a total of at least 682,000 of these houses must be replaced. Most of these (467,000) are located in the rural areas. The roofs leak, the chimneys are defective, the walls are not weatherproof, and foundations are poor. At least another 300,000 of the total number of houses need major repairs, and 235,000 others need minor repairs.

There are 1,217,000 homes in need of sanitary fixtures, including sanitary wells and water pipes, bathrooms, septic tanks, and screened doors and windows. Sanitation is one of the greatest needs of the region, since malaria, hookworm, dysentery, and typhoid are the causes of much chronic illness.

2. *Need for clothing.*—Reasonably exact estimates of clothing needs are difficult to make. Actual clothing expenditures for families vary widely. Certainly, families with gross incomes of $400 to $600, having only $125 to $300 in cash, do not have sufficient clothing. The low-income group probably falls short of the necessary expenditure for clothing by $50,000,000 annually in the region. Additional shortages may occur in the higher-income brackets.

Some budgets for families of five indicate that $160 annually would be required to clothe the family properly. At this rate, annual deficiencies in clothing in the region would be approximately $100,000,000. Textile and clothing-manufacturing industries could be established to use local labor in making these clothes.

3. *Need for household equipment.*—Surveys of household equipment and furniture indicate great shortages. Approximately 790,000 cookstoves, refrigerators, washing machines, sewing machines, beds, springs, mattresses, chairs, tables, sets of dishes, cooking utensils, and so forth are needed. An annual region-wide expenditure of $60,000,000 for maintenance of household furnishings is indicated. Here again, the local manufacture of some of these articles would furnish much needed additional work in the Valley.

4. *Need for adequate nutrition.*—In a nation-wide survey of the nutritional status of this country, the Bureau of Home Economics found that only 50 percent of the farm families had good diets, 25 percent had fair diets, and 25 percent had poor diets. In the villages, 20 percent had good diets, 45 percent, fair; and 35 percent, poor.

None of these sample studies was made in the Arkansas Valley, and these percentages of good and fair diets are believed too high to be applied to this area. Opportunities for farm gardens are limited by dry weather in the western half of the region, and production is generally low in the eastern half.

In another study, Wells and Stiebeling present national figures of food required to meet the diets best adapted to the economic resources of the families. (*Journal of Farm Economics*, February 1940) All low-income families are assumed to follow a low-cost diet plan; all average- to moderate-income families, a moderate-cost plan; and all high-income families, a liberal-diet plan. Expressed in terms of the food needs of the 7,400,000 people of the Valley, this would mean a total yearly diet of approximately the following dimensions:

Food	Amount per person	Total
Milk ..... quarts	295	2,168,545,000
Tomatoes and citrus ..... pounds	122	906,822,000
Potatoes ..... do	157	1,154,107,000
Dried peas and beans ..... do	15	110,265,000
Green, leafy, yellow ..... do	160	1,176,160,000
Other vegetables and fruit ..... do	202	1,484,902,000
Eggs ..... dozens	26	191,126,000
Meat ..... pounds	127	933,577,000
Butterfat ..... do	56	411,656,000
Flour and cereals ..... do	182	1,337,882,000
Sugar ..... do	59	433,709,000

In order that the people of the region may have good nutrition, it is essential first that family incomes be adequate. In addition to an adequate income, extensive educational programs must be carried out so that people may understand the importance of good nutrition and how to obtain good diets. The quantities of food necessary for good diets in the area require a great increase in production, marketing, processing, and storage facilities for the distribution of food products. Generally, equipment for preparation and preservation of food is also essential.

5. *Need for health and medical care.*—The eastern half of the region is comparable to other areas of the South with respect to health conditions. Many of the people are handicapped by poor health. However, health conditions are much better in the western section. In general, the majority of people do not have the funds to pay for adequate medical care.

In 1940, physical examinations of 11,497 Farm Security Administration clients in 21 counties in the Valley showed the need for treatment for an average of 3.6 defects per person.

Group	Number of persons	Defects per person
White family heads and wives	2,371	4.9
White children under 15	2,556	2.4
Negro heads and wives	330	4.3
Negro children under 15	489	2.7

Dental care is likewise inadequate. In one county in Oklahoma, a dental examination of 174 families showed that they needed to have 2,005 teeth filled, 384 teeth extracted, 101 plates, and 152 treatments for pyorrhea.

There is great need for treatment and preventative measures for hookworm, malaria, dysentery, typhoid, and typhus, primarily in the eastern part of the area. In one typical county, examination of 552 children in 15 rural schools showed that 255 were infected with hookworm. A typical weekly report in 1942 from the health department of one State in the area shows 426 deaths from dysentery, 204 from malaria, and 30 from typhus.

Much more sanitation work is also needed in the area. Surveys of State health departments indicate that 91 percent of the rural water supply fails to meet approved standards. Measures are needed to improve the quality of city water supplies now obtained from polluted streams. Seventy percent of the rural homes and many city homes, need sanitary systems for sewage disposal.

A method for bringing medical care to all the people must be developed. A study of 42,803 families in 253 counties in Texas and Oklahoma showed that 7,204 families could not secure medical care unless someone guaranteed the doctor bill; in 16,091 cases of serious illness, 8,456 did not receive the services of a physician; of 3,575 births, 1,153 did not have an attending physician; and 10,558 families had unpaid doctor bills amounting to $481,629.

There is need in the region for more physicians who are better located to serve the people. A survey of 22 counties in Oklahoma indicated there were 316 physicians to 645,774 people, or one physician to every 2,043 people. In 72 counties in Texas, 976 physicians were serving a population of 1,841,242—or one physician to every 1,886 people. Since the war the loss of physicians to the armed forces has reduced the ratio to one physician to every 2,257 people in Oklahoma, and one to every 2,055 people in Texas. In several of the urban centers there are only 500 persons to a physician, while in some rural counties no physicians at all are practicing.

In 1940 the entire Valley, except for Colorado, New Mexico, and Louisiana, had only 4,621 physicians, an average of one to every 1,394 people; however, 1,114 of these were concentrated in five cities. The populations of these cities, together with those of the counties in which they were located, totaled altogether some 770,582 people. This is an average of about 700 people per physician, considerably above the standard of 1,000 per physician; thus the counties adjoining would also probably have enough physicians available. However, this concentration increases the number of persons per physician for the rest of the area to 1,616, or more than 50 percent below the desirable standard.

Area	Number of physicians	Persons per physician	Persons per physician except in concentrated area	Additional physicians needed
High Plains	199	1,115		21
Rolling Plains	408	1,649		265
Central Areas	1,860	1,314	1,548	660
Ozark-Ouachita	1,683	1,367	1,725	889
Forested Coastal Plains	471	1,690		325
Total	4,621	1,394	3,273	2,160

The Valley has about 50 percent of the hospital-bed capacity required to care for the people adequately. Nationally, an average of 8 percent of the population uses hospital services 10 days each year. With an average occupancy of 70 percent, the region would require 23,500 beds. It now has about 13,000 beds.

Area	Number hospital beds now	Number needed	Total number needed
Eastern Slope	910	0	908
High Plains	472	667	1,139
Rolling Plains	1,455	654	2,109
Central Areas	3,967	3,963	7,930
Ozark-Ouachita	3,917	3,293	7,211
Forested Coastal Plains	2,516	1,722	4,238
Total	13,257	10,299	22,627

At present, hospitals are located to serve the larger urban centers. Large areas of rural people are situated as much as 200 miles away from hospitals. In fact, it is the few large urban centers which make the hospitalization picture seem as good as it does.

The shortage of hospitals indicates a shortage also of laboratory and diagnostic equipment which is too expensive for the individual practicing physician in the rural area to buy.

A vigorous medical program in which the medical profession and the communities will work together is required to build up the health of the people. Some of the essentials of such a program are indicated here:

1. An education program to:

(a) Develop the consciousness that health is a matter of public concern and that poor health is a loss to the community as well as to the individual;

(b) Acquaint the people with the principles of nutrition, environmental sanitation, and other factors relating to health;

(c) Teach the safeguards of health through preventative medicine, and make known the opportunities of corrective medicine.

2. A determined all-out drive to eliminate infection due to unsanitary conditions by:

(a) Protecting all domestic water supplies from pollution, and insuring them against subsequent pollution by piping into the kitchens;

(b) Building screened sanitary pit toilets or, prefer-

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ably, installing indoor toilets with sanitary sewage disposal for all homes;

(c) Screening all doors and windows and making other repairs necessary to render all houses insect-proof;

(d) Securing protection from the anopheles mosquito by drainage, spraying, water level control, and other methods of control.

3. The establishment of strong public health units in all counties of the area under the direction of state health departments to:

(a) Operate clinics for examination, treatment, and prevention of communicable diseases;

(b) Promote an educational program for better health and sanitation.

4. The establishment of medical centers around well-equipped hospitals with good laboratories, adequate diagnostic facilities, and sufficient personnel to serve all the people of the region. Such centers would bring to all physicians and patients the advantages now available only in certain urban localities.

5. The establishment on an insurance basis of the group prepayment plan for meeting the cost of medical care. This plan should be the method of approach in solving the medical care problems for the area. It incorporates the idea of cooperation of specialists rather than competition of general practitioners. The field of medicine is too large for any one individual to encompass. Consequently, it is necessary for medical specialists to work together in clinics.

Effective and intelligent practice of modern medicine follows this procedure in urban centers. It is an ideal way of meeting the problem caused by a rapidly developing science. It is also a practical way of meeting the medical needs of low-income groups in rural areas.

THE LAND

Land of the Arkansas Valley varies enormously in quality and agricultural possibilities. This is due partly to the diversity of the soils and partly to great differences in climatic conditions in the area.

Rainfall varies from an annual average of over 60 inches in the extreme eastern portion, bordering on the Mississippi delta, to as little as 10 inches in small areas in the extreme western portion. The average length of the growing season increases from 150 days in the Northwest to 280 days in the Southeast. These variations in climate exert a dominant influence upon the pattern of agricultural use of the land.

The Valley contains a total of 177,228,000 acres, 9 percent of the total area of the United States (table 1). Crops are planted on 49,552,800 acres; 44,546,000 acres are in woodland; and 83,129,200 are in pasture and other uses. Only 128,333,000 acres are actually in farmland, but much of the nonfarmland is used for grazing in connection with farm units. Within the Valley are 646,000 farms, or 10.5 percent of all the farms in the Nation, and 12 percent of all farmland. On these farms $610,000,000 worth of agricultural goods are produced annually, or 7.8 percent of the total value of all agricultural goods in the Nation.

General Characteristics of the Land

Productivity of the land ranges from good yields on the fertile higher plains and prairies to low yields on the relatively poor and rolling lands of the eastern piney woods. Along the streams there is a relatively small but very important amount of alluvial land of high productive capacity. Farms range in size from the large 50,000-acre grazing units of the West, to the small 40-acre and 80-acre cotton farms of the timbered areas.

TABLE 1.—*Land resources of the Arkansas Valley Region, 1940*

	Arkansas Valley	United States
Total area, acres	177,228,000	1,905,361,900
Cropland, acres	49,552,800	399,249,000
Woodland, acres	[1] 44,546,000	137,068,000
Pasture and other, acres	83,129,200	1,369,044,900
Farmland, acres	128,333,000	1,060,852,000
Number of farms	646,000	6,097,000
Value of all farm products (dollars)	610,000,000	7,813,645,000

[1] Includes 27,884,000 acres non-farm woodland.

Based on United States Census of Agriculture, 1940.

Over much of the eastern half of the Valley, small farms and low crop yields combine to keep incomes low; while in the West the great hazard is low rainfall and drought. Crop failures and sequences of crop failures have repeatedly caused farmers to abandon their farms. Severe erosion is caused by water in the East and by wind and water in the West. Large areas in the East have lost as much as one-half the top soil: as a result, crop production is in some instances no longer possible. Natural forces that affect these processes, such as climate, soils, and topography, cannot be readily altered. However, tenure arrangements, management practices, and land use can be altered so as to halt loss of soil and restore and maintain productivity.

Desirable land utilization throughout the Arkansas Valley Region requires two major adjustments:

1. Farms must be reorganized into adequate, efficient units. These must provide an income sufficient to en-

able operators to conserve the soil and meet the hazards of recurring droughts.

2. Programs for soil and forest conservation and management, as well as water use and flood control, must be applied to all farm, range, and forest lands to restore, maintain, and improve their productivity.

Flood Control Through Land Treatment

Proper management and conservation of land has a value which extends beyond the farm. Under proper land use, rotation, cultural practices, erosion control devices, and methods of cropping, water which might otherwise flow quickly into the streams and cause floods is delayed in its flow so that a greater portion soaks into the soil and may find its way to the streams through springs and seeps weeks or months later.

The removal of a forest cover or the plowing of grass lands tends on most sloping land to cause a more rapid and a greater volume of run-off. In addition to the actual washing away of the soil, this rapid accumulation of water in the streams increases the likelihood of overflow and flood damage further down stream.

When cover is maintained and suitable erosion-control measures are used the flow of water over the surface is greatly reduced and the delivery of water to the streams spread over a considerable time. Proper land management is therefore a vital part of a flood-control program.

In the West where surface waters in the streams are collected for irrigation there has been some concern about land treatments lest they decrease the total flow and the supply of water for irrigation purposes. Investigations have not settled this controversy. Flash floods flowing unrestricted over dry soils carry a great burden of silt which tends to fill all storage reservoirs. The absorption of a larger volume of this water by the soil and its slow movement around contours or terraces or through the soil delivers water with less silt for irrigation purposes and tends to maintain a more uniform flow of the streams.

Basic erosion control and land-management practices, as outlined in the analysis of land treatments for each subregion in tables 5, 11, and 17, are also, in effect, flood-control programs.

Subdivisions of the Valley

From the viewpoint of agriculturists, the Arkansas Valley may be divided into nine subregions, distinguished by variations in physiographic factors, mainly climate, soils, and topography. (See Fig. 5.) They are:

1. Eastern Slope.
2. High Plains.
3. Rolling Plains.
4. Central Prairies.
5. Cross Timbers.
6. Osage and Flint Hills.
7. Eastern Prairies.
8. Ozark-Ouachita Highlands.
9. Forested Coastal Plains (formerly called Rolling Sandy Lands).

While these subregions differ materially in land-use, crop, and livestock enterprises, as well as in many details of management, they have been grouped for this brief analysis into three areas—the western, central, and eastern areas.

The western or low-rainfall area of the Valley consists of three subregions. Actually these are transition zones from the Rocky Mountain highlands to the lower-lying timbered and prairie areas to the east. The elevation of these subregions from West to East is as follows: Eastern Slope, 10,000 to 5,000 feet; High Plains, 5,000 to 3,000 feet; and Rolling Plains, 3,000 to 1,000 feet.

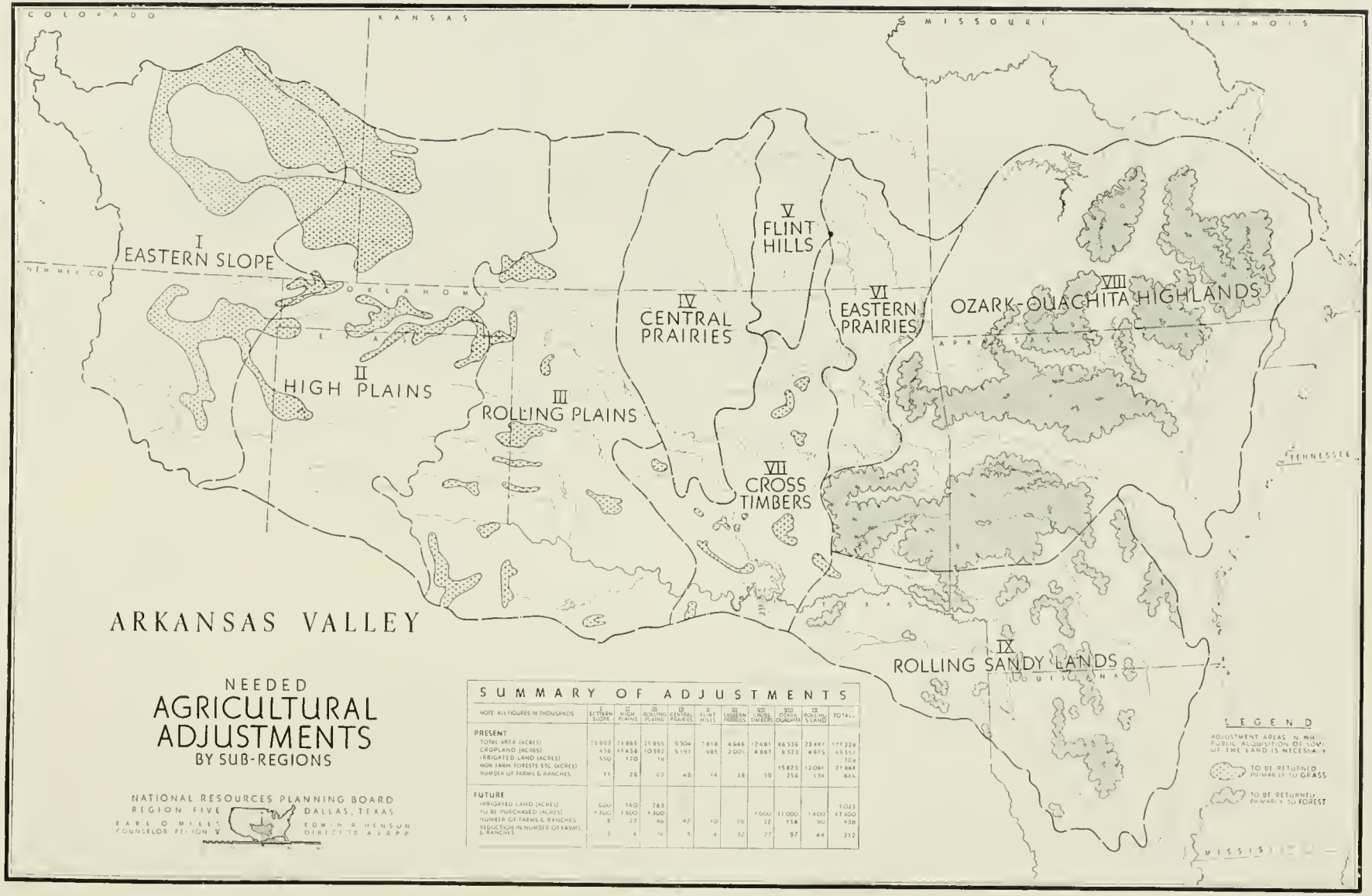
The central area, with ample rainfall, includes the level Central Prairies, the rough Cross Timbers, the Osage and Flint Hills, and the eastern prairies. Central Oklahoma and corresponding areas in Kansas to the north and in Texas to the south are also part of the central area.

The eastern area consists of the Ozark-Ouachita Highlands of Missouri, Arkansas, and eastern Oklahoma, and the Forested Coastal Plains of southern Arkansas, northern Louisiana, and northeastern Texas.

Western Area

Except in a limited expanse of land high up in the Rockies, this great area of 76,812,000 acres is grass-covered and generally treeless. Short grass prevails except on alluvial bottom lands and in the vicinity of the eastern boundary. High winds sweep over the surface and evaporation rates are exceedingly high. Annual rainfall varies from 10 inches in desert-like areas in the West to 30 inches in the East. Small localities in the mountains receive as much as 40 inches of rain annually.

The soils vary from dominantly sandy in the Rolling Plains to dominantly hard lands (silt loams and clay loams) on the High Plains. Sandy lands occur in small areas and along river channels throughout the entire region. The soils generally are fertile and very productive when sufficient moisture is present, either through normal rainfall or irrigation. Sandy lands are subject to blowing during dry years, and generally should be kept in grass. Drifting soils from these lighter soil areas frequently accumulate on the heavy soils, covering crops and reducing productivity of the more fertile lands.



SUMMARY OF ADJUSTMENTS

NOTE: ALL FIGURES IN THOUSANDS	I EASTERN SLOPE	II HIGH PLAINS	III ROLLING PLAINS	IV CENTRAL PRAIRIES	V FLINT HILLS	VI EASTERN PRAIRIES	VII CROSS TIMBERS	VIII OZARK-OUACHITA	IX ROLLING SAND LAND	TOTAL
PRESENT										
TOTAL AREA (ACRES)	25 097	24 865	25 955	9 304	3 818	4 646	12 681	46 536	23 441	177 228
CROPLAND (ACRES)	456	11 438	10 592	5 191	985	2 005	4 887	8 523	4 675	49 552
IRRIGATED LAND (ACRES)	550	170	18							704
NON FARM FORESTS ETC. (ACRES)							15 823	12 061		27 884
NUMBER OF FARMS & RANCHES	11	26	63	46	14	38	59	256	136	649
FUTURE										
IRRIGATED LAND (ACRES)	600	140	283							1 023
TO BE PURCHASED (ACRES)	1 700	1 500	1 300				1 600	11 000	1 400	17 400
NUMBER OF FARMS & RANCHES	8	22	46	42	10	26	32	158	90	434
REDUCTION IN NUMBER OF FARMS & RANCHES	3	4	16	4	4	12	27	97	44	212

FIGURE 5.

Use of the Land

The western area, significant historically in relation to cattlemen-homesteader feuds, has not yet satisfactorily resolved these old problems. Tax rates on land that might be plowed make it difficult for the owner to keep it in grass. Dry years and sequences of dry years make it difficult for him to continue raising crops. In the western counties where homesteading under Federal policies occurred (in all States except Texas), tax-delinquent lands are a great problem to the States. Such lands are difficult to manage, as the cost of clearing title and securing possession often exceeds the resale value. Grazing, row crops (sorghums), and wheat are the principal uses of the land, except in irrigated areas.

Some 800,000 acres are irrigated out of the total area of 76,812,000 acres. On these lands assured supplies of water are used in producing specialized crops, feed, and forage. While the acreage is limited, the gross income from these acreages is relatively high and problems center around the water supply, labor, and markets. Irrigation developments afford opportunities for a greatly increased number of gainfully employed people in the area both on the farms and in service industry. The broad general use of the land in the western area, together with the number of farms there, is indicated in table 2.

TABLE 2.—*Land use in the western area*

Item	Eastern Slope	High Plains	Rolling Plains	Total
Total land area	25,992,000	24,865,000	25,955,000	76,812,000
Cropland	1,455,600	11,437,900	10,392,400	23,285,900
Woodland	1,689,500	228,800	236,200	2,154,500
Grazing and other	22,846,900	13,198,300	15,326,400	51,371,600
Farmland	18,194,400	22,875,800	23,619,000	64,289,200
Number of farms	10,600	25,500	62,300	98,400
Owner operated	7,840	13,650	32,000	53,490
Part owner and tenant operated	2,760	11,850	30,300	44,910

Based on United States Census of Agriculture, 1940.

The three subregions are about the same size. However, the cropland is largely in the two easternmost sections, where most of the 98,400 farms are also located.

TABLE 3.—*Size of farm units in the western area*

Size	Eastern Slope	High Plains	Rolling Plains
Acres	*Percent*	*Percent*	*Percent*
0–49	24	10	10
50–99	8	5	9
100–179	4	13	30
180–259	7	4	11
260–499	19	24	25
500 and over	38	44	15
Total	100	100	100

Based on United States Census of Agriculture, 1940.

The recommended size of a farm in these subregions varies from approximately half a section (320 acres) in all but the irrigated area and the cotton-producing portion of the southeastern section, to 4,000 acres in the West for family-size enterprises. Farms of 160 acres which produce some cotton, and strictly irrigated farms of 80 to 160 acres, are also recognized as being adequate units. The present size of farms is given in table 3.

Crop agriculture here is of recent origin. Most of the "breaking out" of the sod has occurred during the last 40 years. Much of the expansion in crops took place following the first World War. At the present time, grazing is the chief enterprise on the Eastern Slope. Cattle constitute the most important kind of livestock, although there are growing numbers of sheep in the South. Dry-land farming consists primarily of grain sorghums for feed, with some wheat. Alfalfa, sugar beets, vegetables, fruit, and some small grains are grown under irrigation. In the drier western portions of the High Plains the chief enterprise is grazing, with grain and forage sorghums for feed. In the remaining portion of this subregion, wheat is the principal crop, followed by livestock and grain sorghums.

Farms are smaller in the Rolling Plains—almost one-half of them are 160 acres or less. In the North, wheat, grain sorghums, and beef and dairy cattle are produced. General farming, with cotton, wheat, and grain sorghums, is practiced in the South. Though numerically not impressive, large ranches include one-half the farm land in some of the northern portions. They are also important in the South on the Texas side of the Red River.

In these subregions, gross farm incomes are relatively high (table 4). While only one-sixth of all farms in the Valley are located here, they produce more than one-fourth the total value of agricultural goods raised in the Valley. However, there are many units in these dry-land areas where gross incomes are low; they are generally small farms where cropping is the sole enterprise.

Gross farm income figures shown in table 4 include the milk, eggs, vegetables, and other products grown and consumed on the farm, figured at the market price for those products.

TABLE 4.—*Gross farm income in the western area*

Gross income	Eastern Slope	High Plains	Rolling Plains
Dollars	*Percent*	*Percent*	*Percent*
0–399	54	32	19
400–599	10	11	11
600–999	12	15	21
1,000–1,499	8	12	18
1,500 and over	16	30	31
Total	100	100	100

Based on United States Census of Agriculture, 1940.

Problems of the Area

Except in Texas, the western area was settled under the Homestead Act, which permitted each family to

acquire from 160 acres to 320 acres. Texas granted and sold land in larger acreages, which were then "promoted" and settled.

Farmers on the small tracts plowed the land, and planted crops much as they had in the more humid eastern areas. Sequences of dry years brought disaster, and many families abandoned their land. A succession of good years would see the land "promotionally" resettled, only to be abandoned again when the dry years came.

Diversification was not practiced on these small farms because in dry years feed was so scarce farmers were compelled to sell their cattle. This forced even greater reliance on grain crops.

Original land settlement policies and practices are responsible for many of the problems revolving about the land and its use.

The average rainfall of this area is not only low; it is also so variable that in many years production of crops, and even of grass, is a failure. These dry years, and cycles of dry years, are hazards to agriculture which only careful planning can lessen.

When grass fails to produce normally on the ranches, the operator is forced by early fall to purchase feed or sell his herd. On the other hand, even when the grass and crops fail in the combination rowcrop and livestock area, a reserve supply of bundle feed will stand the farmer in good stead provided the drought is short. The one-crop wheat farmer and his family suffer untold hardships. It is the farmers of this group who abandon their land during dry years. In this area that is why even a small acreage under irrigation has a great stabilizing effect. With about one-half million acres in irrigation and approximately 76 million acres in ranches and dry farming, the stabilizing influence of the irrigated land could be very great.

During the recent drought in the nineteen-thirties, most of the range cattle and practically half the breeding herds had to be sold because of feed shortage. When this situation occurs, years are required to replace these herds in the area.

A program necessary for the stabilization of this area therefore includes the creation on the farm of a reserve feed supply in good years, this reserve to be used to carry livestock through the poor years. Sorghums and other feed stored in trench silos will keep for a number of years. Under such a program each livestock farmer would be urged to take full advantage of this method of storage and carry feed sufficient for at least one full season.

In addition to this, irrigated land could be used to produce alfalfa and other feeds regularly by stabilizing the price through an ever-normal feed storage loan that would provide a market for hay in abundant years, and release this feed from storage in times of drought. Such a program need not involve subsidy. An organizational effort through educational agencies should suffice to initiate a completely self-liquidating cooperative feed service.

The development of the limited irrigation possibilities of the upper Canadian Rivers, the Washita, the Cimmaron and other tributaries of the Arkansas and Red Rivers should be used for the stabilization of farming generally in this dry farming area. On such projects the water user may not be assessed with as great a share of the construction costs as is customary, certain limitations may be placed on the use of the water, and benefits may be expected to accrue to wider areas. This contribution to regional farm security should be recognized in evaluating specific proposals for such projects.

In such a development crop insurance has a place. The general and continuous use of crop insurance would distribute the income over the years and bring increased stability to farming.

The sandy areas of the Rolling Plains are admirably suited to shelter-belt plantings, which have generally been satisfactory and have added an element of permanence and stability to homes in this area. On these treeless plains, rows of trees breaking the wind increase crop production by lowering evaporation rates, prevent soil from blowing, afford shelter for stock, and add immeasurably to the attractiveness of the area. Later these belts will furnish wood, posts, and other material for use.

Adjustments

Every effort should be made to develop and use all available water for irrigation and to protect rich alluvial lands and irrigation systems from flood damage. Vigorous action to control land use must be taken by the people of the communities. Working through locally established soil conservation districts, farmers can protect their community by making their own regulations and seeing that everyone observes them. Plowing of grass land on lighter soils creates a wind erosion hazard seriously affecting the economy of entire communities. When these lands begin to blow it is extremely difficult to stabilize them, and still more difficult to reestablish a grass cover.

Farm organizational changes necessary in the western area are shown in figure 5 and in table 6, respectively. Specific recommendations are as follows:

1. *Farm reorganization.*—A reorganization of farm units and ownership patterns to give the maximum number of operators a desirable income and bring about wider use of available water. Even with proper distribution, land and water apparently are not enough to maintain all farmers within the area. Twenty-three

thousand farms in the region should be absorbed in other units.

2. *Stabilized economy.*—Unit reorganization should stress the stabilization of the entire farm economy of the subregions. Feed reserves to carry livestock in dry years should be kept in trench silos by means of feed loans. Through ever-normal granary and cooperative procedures, alfalfa and other feeds raised on irrigated lands should be stored for use during dry years. To aid in lessening severe effects of drought on wheat farmers, crop insurance should be for a period of several years rather than for one year at a time. Wheat farming in the upper areas should be combined with livestock production. Tax assessments should be adjusted to help keep land in its best long-time use. Recognized improved leasing and rental arrangements must accompany the adjustments.

3. *Irrigation.*—Three hundred twenty thousand acres can be added to lands irrigated with surface water by proper and more widespread use of water; at least 50,000 new acres can be developed through irrigation from ground water. (See Water Development under irrigation.) All irrigation systems requiring improvements should be replanned and rehabilitated.

4. *State water control.*—State and local regulation of underground water use based on adequate study of underground reserve is essential.

5. *Conservation and use.*—A comprehensive adjustment program must be initiated for soil and water conservation and land use. This would include terracing, water retention devices, shelter-belt planting, and other measures. Nearly 3,000,000 acres of cropland should be returned to grass. To carry out this job of conservation, 377,000 man-years of labor would be required (table 5).

TABLE 5.—*Measures to be installed and man-years of labor necessary for conservation of soils and water in the western area—preliminary estimates, Arkansas Valley*

Measure and unit	Eastern Slope	High Plains[1]	Rolling Plains	Total
Acres, terraces	1,134,000	11,210,000	6,782,000	19,126,000
Acres, diversions	2,442,000	1,180,000	2,018,000	5,640,000
Acres, contour furrows	9,740,000	11,789,000	3,871,000	25,400,000
Acres, woody plantings	14,400	34,100	208,700	257,200
Acres, sand dune control	4,400	16,400	2,400	23,200
Acres, cover crop and revegetation	1,226,000	2,236,000	993,000	4,455,000
Miles, fence construction	17,480	23,800	24,960	66,270
Miles, highway grading	3,055	7,100	10,000	20,155
Miles, farm roads	840	1,300	2,400	4,540
Number, irrigation structures	715	139	277	1,131
Miles, supply canals	1,223	578	214	2,015
Miles, canal rehabilitation	4,626	292		4,918
Number, irrigation wells	259	133	430	822
Acres, hummock leveling	391,000	652,000		1,043,000
Number, farm ponds	8,110	8,000	21,670	37,780
Number, stock water wells	1,230	1,780	7,200	10,210
Acres, timber stand improvement	79,000			79,000
Man-years of labor	73,000	79,000	225,000	377,000

Based on preliminary estimates by the Soil Conservation Service, U. S. Department of Agriculture.

[1] Includes Canadian breaks.

NOTE.—Miscellaneous measures such as cutting posts, fence line clearing, streambank and highway plantings, ditch construction, mulching, etc., not shown. "Man-years of labor" includes labor necessary for these measures.

6. *Land use, control.*—Adjustment of land to its best use would require special restrictions and public control of the use of 4,000,000 acres. The greater portion of this acreage is land subject to wind erosion that should be returned to grass.

7. *Soil conservation districts.*—Organization of these districts should be stimulated so that, through them, the local people can prevent misuse of the land and carry out a conservation program.

TABLE 6.—*Summary of adjustments, western area*

	Eastern Slope	High Plains	Rolling Plains	Total
Present:				
Total area (acres)	25,992,000	24,865,000	25,955,000	76,812,000
Cropland (acres)	1,456,000	11,437,900	10,392,000	23,285,900
Irrigated land (acres) (approx.)	610,000	165,000	36,000	811,000
Number of farms and ranches	10,600	25,500	62,300	98,400
Future:				
Irrigated land (acres)	655,000	250,000	275,000	1,180,000
Purchased (acres)	1,200,000	1,500,000	1,300,000	4,000,000
Number of farms and ranches	7,600	21,500	46,300	75,400
Reduction in number of farms and ranches	3,000	4,000	16,000	23,000

Based on preliminary estimates by the Soil Conservation Service, U. S. Department of Agriculture.

Central Area

The central area of the Arkansas Valley includes the Central Prairies, Flint Hills, Eastern Prairies, and Cross Timbers sections.

Level prairies interspersed with rolling lands covered with scrub oak, black-jack, and other timber of little commercial value, largely characterize this great area. Rainfall normally is ample for crop production, varying from 30 to 40 inches annually. Supplemental irrigation on the rich alluvial lands toward the west appears necessary about every 3 years. Prairie soils in the north are generally productive, although soils in the area as a whole are medium to low in productivity. Erosion is severe on the rolling lands, and much of the natural fertility has been lost.

Use of the Land

The relatively small farms, originally cleared in the process of settlement, frequently have been further divided until the area generally is one of very small units. Those in the northern section where wheat is raised and those devoted to grazing in the Flint Hills are more nearly adequate than farms in the Cross Timbers and Eastern Prairies. The inability of Indians to sell lands allotted to them in 40-acre units complicates the problem of assembling adequate units in certain areas of Oklahoma.

Farm products valued at $197,550,000 are raised on the 158,000 farms in these subregions.

Farm units do not vary so greatly in size in the central area as in the semiarid sections of the Valley. The only exception to this is in the Flint Hills, where cattle

grazing is the principal enterprise. In the central prairies, typical farms contain 160 acres and 320 acres. In the Cross Timbers and Eastern Prairies, nearly one-half of all units are less than 100 acres in size. Such units are entirely too small, considering the poor soils, limited tillable acreage, types of farming, and available markets.

TABLE 7.—*Major land use in the central area*

Item	Central Prairies	Flint Hills	Eastern Prairies	Cross Timbers	Total
Total land area	9, 304, 000	3, 818, 000	4, 646, 000	12, 681, 000	30, 449, 000
Cropland	5, 191, 600	985, 000	2, 005, 200	4, 887, 200	13, 069, 000
Woodland	259, 600	131, 400	192, 800	2, 697, 800	3, 281, 600
Grazing and other	3, 852, 800	2, 701, 600	2, 448, 000	5, 096, 000	14, 098, 400
Farmland	8, 652, 700	3, 283, 500	3, 856, 200	10, 398, 400	26, 190, 800
Number of farms	46, 400	14, 600	37, 700	59, 300	158, 000
Owner operated	25, 000	7, 400	18, 500	23, 400	74, 300
Part owner and tenant operated	21, 400	7, 200	19, 200	35, 900	83, 700

Based on United States Census of Agriculture, 1940.

TABLE 8.—*Proportion of total farms by size groups in the central subregions*

Size	Central Prairies	Flint Hills	Eastern Prairies	Cross Timbers
Acres	*Percent*	*Percent*	*Percent*	*Percent*
0–49	16	14	26	22
50–99	11	12	22	25
100–179	31	27	26	33
180–259	13	15	12	10
260–499	23	20	11	8
500 and over	6	12	3	2
Total	100	100	100	100

Based on United States Census of Agriculture, 1940.

General farming is practiced in these subregions with the exception of the Flint Hills, where grazing is the main enterprise, since almost all the land is best suited to this purpose. Investments are large, both in livestock and land.

General Farming of the Central Prairies includes wheat as a cash crop with grain sorghums and oats grown for livestock feed. Farm investment is usually above $10,000.

In the southern part of the Eastern Prairies there are a larger number of small cotton and corn farms. Another group of small farms, many part-time, is concentrated around the Tri-State lead and zinc area. These furnish very meagre incomes. Cotton and corn are the principal enterprises in the Cross Timbers. Some dairying and trucking are practiced, but progress in these enterprises has been slow. A great proportion of total incomes here is counted in terms of products used in the home. The level of living of farm families is very low. In contrast to the small cotton and corn farms, there are a few highly successful livestock units ranging up to 4,000 acres in size.

Gross farm incomes vary widely between these subregions. In general, the Central Prairies are characterized by relatively high returns. Although only 6 percent of all farms in the Valley are situated in this subregion, twice this proportionate value of farm products originates here (table 9). In the Eastern Prairies and Cross Timbers low incomes prevail. Nearly 6 out of every 10 farmers receive less than $600 annually, including food raised and consumed on the farm.

TABLE 9.—*Proportion of farms by amount of gross income in the central area*

Gross income	Central Prairies	Flint Hills	Eastern Prairies	Cross Timbers
Dollars	*Percent*	*Percent*	*Percent*	*Percent*
0–399	29	26	38	40
400–599	8	13	16	19
600–999	15	20	21	21
1,000–1,499	15	15	12	10
1,500 and over	42	26	13	10
Total	100	100	100	100

Based on United States Census of Agriculture, 1940.

Problems of the Area

The Central Prairies and the Flint Hills are generally the best-adjusted areas in the Valley, although too much emphasis is placed on wheat in the Central Prairies. A more diversified program with livestock and sorghums would provide more security here.

The Cross Timbers and Eastern Prairies have a very serious problem of soil erosion. A great portion of the cropland in these areas should be returned to grass. The alternative to this shift is the almost complete destruction of the agricultural usefulness of such land in a short time; the seriousness of the threat to land productivity here cannot be overestimated. Land that remains in crops will require elaborate and costly erosion control measures.

Tenure problems arise out of a situation whereby scattered Indian lands are held in small units and leased to individuals without regard to the blocking up of adequate farms. Original settlement was also made on small holdings, thereby adding to current difficulties encountered in carving out adequate farms. Landlord-tenant arrangements are such that conservation actually may be discouraged. Moreover, the better land of this area, which lies in the narrow alluvial sections along the streams, is subject to floods, and its great productivity is reduced by delayed plantings and actual crop destruction.

Adjustments

Any program of adjustment in this area must provide for the removal of many families from the small farms. This does not mean that some of them may not continue to live in the rural areas and work in industry or trades. The production of cotton on poor worn-out soils hastens the destruction of the land and continues in almost abject poverty the families trying

to produce it. The following recommendations are in line with general plans made by land-use planning committees in the area:

1. *Farm reorganization.*—Erosion and land-use problems in the Cross Timbers are so critical that the number of farms there should be reduced by nearly one-half, a reduction of about 27,000 farms. This means a radical shift in present tenure or land-holding arrangements. Accompanying this reorganization there should be the abandonment of cash crop (wheat) farming in the Flint Hills. Type of farming in the Cross Timbers and Eastern Prairies should be shifted to livestock, pasture, peanuts, sweetpotatoes, feed crops, and truck, with cotton grown only on the richer alluvial lands. The number of farms would be reduced by 48,000 by this reorganization of units.

2. *Conservation and use.*—A land-use adjustment and conservation program is necessary on all land in the central area. This includes runoff retardation measures to reduce flood flows downstream. Nearly all cropland in the Flint Hills should be returned to pasture. Stocking rate should be adjusted to long-time range-carrying capacity. Conservation measures and man-years of labor required for installation are shown in table 11.

3. *Land-use adjustment.*—In addition to minor shifts in use of land on individual farms larger tracts now in farmlands should be shifted to timber production and grazing with suitable forest management practices in operation. There are 1,000,000 acres of land in the latter classification.

4. *Other measures.*—Institutional adjustments and roads planned to serve the area at the least cost are required.

TABLE 10.—*Summary of adjustments, central area*

	Central Prairies	Flint Hills	Eastern Prairies	Cross Timbers	Total
Present:					
Total area (acres)	9,304,000	3,818,000	4,646,000	12,681,000	30,449,000
Cropland (acres)	5,191,000	985,000	2,005,200	4,887,300	13,068,500
Number of farms and ranches	46,400	14,600	37,700	59,300	158,000
Future:					
Purchased (acres)	-------	----------	----------	1,000,000	1,000,000
Number of farms and ranches	41,700	10,300	25,700	32,300	110,000
Reduction in number of farms and ranches	4,700	4,300	12,000	27,000	48,000

TABLE 11.—*Measures to be installed and man-years of labor necessary for conservation of soils and water in the central subregions (preliminary estimates)*

Measure and unit	Central Prairies	Cross Timbers	Flint Hills	Eastern Prairies	Total
Acres, terraces	2,707,000	2,372,000	1,095,000	1,816,000	7,990,000
Acres, diversions	204,000	182,000	367,000	41,600	194,600
Acres, drainageway	52,370	182,000	4,400	254,000	492,770
Acres, contour furrows	781,000	789,000	208,000	537,000	2,315,000
Acres, pasture clearing	215,250	213,000	306,000	256,000	990,250
Acres, pasture planting	814,000	1,205,000	145,000	292,000	2,456,000
Acres, woody plantings	75,000	226,500	21,700	46,000	369,200
Acres, gully plantings	41,700	119,300	14,300	16,700	192,000
Miles, fence construction	23,500	28,200	16,500	18,800	87,000
Miles, highway grading	8,900	4,500	3,100	4,700	21,200
Miles, farm roads	7,600	18,000	700	4,500	30,800
Rods, gulley diversion	641,600	596,500	836,000	769,000	2,843,100
Number, farm ponds	14,500	11,800	9,900	8,500	44,700
Number, stock water wells	1,450	1,900	200	300	3,850
Acres, timber stand improvement	----------	2,060,000	102,000	132,000	2,294,000
Man-years of labor	90,000	172,000	33,500	62,100	358,300

Based on preliminary estimates by the Soil Conservation Service, U. S. Department of Agriculture.

NOTE.—Miscellaneous measures such as cutting posts, fence line clearing, streambank and highway plants, ditch construction, mulching, etc., not shown. Man-years of labor includes necessary labor for these measures.

Eastern Area

This area includes the forested Ozark-Ouachita Highlands and Forested Coastal Plains. (Fig. 5.)

Hardwoods formerly covered most of the Ozark-Ouachita area, and much valuable timber can still be and is being produced there. This area is rough and rugged, reaching almost mountainous proportions. Valleys are narrow with rather steep slopes. The great valley of the Arkansas River, 10 to 40 miles wide, is a principal topographic feature, cutting through the entire area.

The Forested Coastal Plains lie at a lower elevation, down almost to 100 feet, are not so rugged, and are covered with pine and hardwoods.

Rainfall is heavy—40 to 60 inches annually. Streams flowing from the highlands are clear and swift, containing important power possibilities. Streams in the South are sluggish and drainage is a problem. Soils generally are thin, stony, and badly leached and eroded on the hills. Narrow valleys have a limited area of rich alluvial land subject to severe loss of production from floods. The soils of the Forested Coastal Plains are light in color and low in productivity. Bottom-land soils are productive when well drained.

Use of the Land

Use of land for crops in these humid areas is limited, particularly in the Ozark-Ouachita Highlands, by the

prevailing topography and the original shallow stony soils. Of a total area of almost 70 million acres, or two-fifths of the entire Valley, only 37,453,000 acres are in farms (table 12). Cropland represents slightly more than one-third of the farmland acreage, or 13,197,800 acres. Nonfarmland areas, 32,514,000 acres in extent, are covered by a potentially valuable timber growth. Sixty percent of all the farms in the Valley, or 389,600 farms, are situated in the eastern area (table 12). However, only 40 percent of the value of all Valley farm products is derived here, or $253,106,000, as compared with the Valley total of $610,000,000.

TABLE 12.—*Major land use, number of farms and type of operator in the eastern area*

Item	Ozark-Ouachita	Forested Coastal Plains	Total
Total land area	46,526,000	23,441,000	69,967,000
Cropland	8,522,800	4,675,000	13,197,800
Woodland	23,441,000	15,669,000	39,110,000
Grazing and other	14,562,200	3,097,000	17,659,200
Farmland	23,636,000	10,817,000	37,453,000
Number of farms	255,600	134,000	389,600
Owner operated	151,900	59,880	211,780
Part owner and tenant operated	103,700	74,120	177,820

(Based on United States Census of Agriculture, 1940.)

Farming in the two subregions is similar in many respects. Farms are exceedingly small, typical ones being 40 acres and 80 acres in size (table 13). Two-thirds of all the units are in these groups, more than three-fourths of them being in the Forested Coastal Plains. Cropland acreage on such farms is small, varying from 18 acres to 35 acres, respectively. Another situation common to both subregions is the crude techniques used in production. Tools and equipment are of the one-horse, half-row type. "Patch" cultivation is universally prevalent. Investments are small, totaling from $1,200 to $2,000.

TABLE 13.—*Proportion of farms by size groups in the eastern subregions*

Size	Ozark-Ouachita	Forested Coastal Plains
Acres	*Percent*	*Percent*
0–49	38	52
50–99	25	25
100–179	22	15
180–259	7	4
260–499	5	3
500 and over	3	1
Total	100	100

Based on United States Census of Agriculture, 1940.

Still another feature in common is the prevailing low incomes. Almost one-half of all operators receive less than $400 gross income from their farms annually (table 14). Most of this amount comes from the use of farm products in the home. Actually annual gross cash income is less than $200. Two-thirds of the farm families receive less than $600 per year. Only 13 out of every 100 farmers have yearly incomes of more than $1,000.

TABLE 14.—*Farm income in the eastern subregions*

Gross income	Ozark-Ouachita	Forested Coastal Plains
Dollars	*Percent*	*Percent*
0–399	46	45
400–599	19	24
600–999	20	20
1,000–1,499	8	6
1,500 and over	7	5
Total	100	100

Enterprises vary between and within these subregions. In the northern Ozarks, farming is general and self-sufficing. In the foothills to the south, cotton becomes the chief crop. Fruits, truck farming products, poultry, and dairying specialties have developed in some areas, particularly in the northwestern portions. Widespread cotton, corn, and truck farming is located in the alluvial soils of the Arkansas River. In the Forested Coastal Plains, cotton and corn are the main crops, with truck farming and dairying developed in a few instances. Some timber products contribute to incomes on many farms. Plantation cotton and corn farming prevail on the Red River alluvial lands.

Forestry

Trees have been, and still are, one of the basic crops of this part of the Valley. These subregions are parts of two of the great forested areas of the United States. Two-thirds of all this land is still in one stage or another of timber growth. In the Ozark Area, mixed hardwoods consisting chiefly of oaks, hickories, gums and lesser species are predominant, whereas in the Ouachita Highlands shortleaf pine in mixture with similar hardwoods is the principal component of most forest stands. Total woodland acreage in the Ozark-Ouachita Highlands is 23,441,000 acres.

The principal forest type in the Forested Coastal Plains consists of loblolly and shortleaf pine. Mixed upland hardwoods, including some scrub, are prominent in part of Texas and southeastern Oklahoma. Bottom lands support characteristic hardwoods and some cypress and tupelo. Practically all these types are used commercially for the manufacture of lumber, pulp, poles, and fuel. Total woodland here amounts to 15,669,000 acres (table 15).

About three-fourths of the forest land in this area is held by private owners in the Ozark-Ouachita Highlands, while in the Forested Coastal Plains 90 percent is similarly owned. Farm woodland makes up nearly one-half of total private holdings in the former area, while slightly less than one-fourth is included in such holdings in the latter area.

TABLE 15.—*Forest area and type of ownership by subregions*[1]

Ownership	Ozark-Ouachita Highlands	Forested Coastal Plains	Total
	Acres	*Acres*	*Acres*
Total area	23,441,000	15,669,000	39,110,000
Private ownership:			
Farm woodland	7,618,000	3,608,000	11,222,000
Other private	9,802,000	10,722,000	20,524,000
Total private	17,420,000	14,330,000	31,750,000
Public ownership:			
National forests	3,599,000	416,000	4,015,000
State forests	34,000		34,000
State parks	44,000	9,000	51,000
Tax delinquent	2,344,000	914,000	3,258,000
Total public	6,021,000	1,339,000	7,360,000

[1] Data from U. S. Forest Service.

Seventy-seven percent of the privately owned forest land in the Forested Coastal Plains is in the possession of extensive industrial groups. Much of this is held in units amounting to over 100,000 acres, usually operated in connection with large sawmills and other lumber industries. National forests are limited almost solely to the Ozark-Ouachita Highlands. Tax-delinquent forest lands are indicated as publicly held, although the exact status of much of these lands is not clear. There is little or no definite forest management outside of the national forest lands and a few private holdings.

Forest stands in the hardwood subregion are producing less than one-half of their capacity. In the Ouachita section, old growth predominates on 19 percent, second growth of sawlog size on 34 percent, second growth under sawlog size on 45 percent, and no tree growth on 2 percent of the woodland area. Identical information is not available for the Ozark section, but general observation indicates that compared to the Ouachita there is less area in old growth and a higher proportion in under-sawlog-size timber, with other conditions about the same.

The Forested Coastal Plains are producing about one-half of their capacity, old growth occupies 12.5 percent of the woodland area, second growth stands producing sawlogs occupy 61 percent, and second growth producing materials less than sawlog size cover 24 percent of the area.

Forest increment amounts annually to an estimated 686 million cubic feet in the Forested Coastal Plains and 390 million cubic feet in the Ozark-Ouachita Highlands. Under proper management, net growth in the two areas can be increased to more than 4 billion cubic feet annually.

Total annual forest increment or yearly growth is estimated at 686 million cubic feet for the Forested Coastal Plains and 390 million cubic feet for the Ozark-Ouachita Highlands, totaling slightly more than 1 billion cubic feet including 3½ billion board feet of material grown by trees of saw-timber size. Under intensive forest management and after a long period—probably more than 100 years—it appears feasible for these lands to be producing annually around 4 billion cubic feet, of which more than one-half or about 11 billion board feet would be from trees of sawtimber size.

The urgency of striving for this goal is indicated by current estimates which show that under demands brought on by war the timber being cut and destroyed on these areas is in excess of increment. Even in the comparatively low timber production year of 1936, for softwoods the drain was 85 percent of forest increment and for hardwood the two were about in balance.

The importance of timber in this area is reflected in the number of industries which depend primarily on woodland products. In the Forested Coastal Plains there are approximately 980 of these units, including 860 sawmills, 7 veneer plants, 14 cooperage plants, 5 pulp mills, and 94 other miscellaneous plants. These industries probably furnish more than 76,000 man-years of labor annually. In the Ozark-Ouachita Highlands, 770 plants are primary wood users. These include 616 sawmills, 95 cooperage plants, and 59 miscellaneous establishments. More than 41,000 man-years of labor are required annually in these industries.

Problems of the Area

Land problems in the eastern area stem from early settlement and misuse. Migrants pushed into these subregions from the "Old South," seeking new opportunities in the form of new lands. They had to cut and burn the forests to make way for crops, and they settled on small tracts such as they had had farther to the east. Much land was cleared and plowed which should have been left in timber.

During later settlement, after the Civil War, timber was in great demand, for the Nation was building cities and railroads. Cutting and slashing of timber received new impetus. Lumber was the primary objective now, not land, and much good timber was wasted. The farmer followed behind the sawmill. Clearing was easier. Population grew as the forests were destroyed. Urban communities grew and prospered in direct proportion to the rate of exploitation of the woodlands. As lumbering passed its peak and declined, many fell back on farming as an occupation. As long as the timber furnished part-time employment, these farmers had a degree of prosperity. Forest and farm employment have been closely interrelated.

At present, the outstanding feature of the land is the overwhelming population dependent on it for a livelihood. Soils are seriously eroded and fertility, never very high, is half depleted. Forests have been cut over and burned until the growing stock is so severely depleted that years will be required to rehabilitate it. The drain on the timber resources is greater than the natural growth. Water runoff is large and floods do serious damage. Resources in terms of trees and soils are shrinking, while the number of people liv-

ing on these resources is constant or increasing. Timber exploitation has left many farmers and communities stranded and without a resource base. Small farms furnish only 125 to 150 days' employment annually for about 150,000 farmers.

Under-employment, crude agricultural techniques, low soil productivity, and a depleted woodland resource, all combine to maintain extremely low incomes. Exploitative practices and land misuse are accelerated under the pressure to supply essential family needs and minimum cash expenses. Further removed from the farmers' everyday lives, but not less influential, are land tenure, taxing, and credit systems which all further depress living standards. Tenancy of the crop-share and cropper type is the usual method of operation in the Forested Coastal Plains. The population is constantly shifting, and landlord-tenant relationships are such that cash cropping and resource depletition are promoted. Interest rates on production loans are very high for this group of farmers.

Adjustments

Adjustments in the eastern area must provide and maintain opportunity for a maximum number of people on the land. Doing this requires several lines of action which have been recommended by farmers and workers in agricultural fields.

1. *Farm reorganization.*—A complete reorganization of land tenure and rental arrangements is necessary to provide full employment and security for a maximum number of farm people. This will require a reduction in the number of farms and transfer of people to other occupations or to other areas. Total reduction amounts to 141,000, or 97,000 in the Ozark-Ouachita Highlands, and 44,000 in the Forested Coastal Plains.

2. *Land use.*—In making these reductions a shift in types of farming is necessary. Extensive rather than intensive agriculture appears to be more feasible over the whole area. Livestock, peanuts, sweet potatoes, and feed crops should be increased. Truck farming, dairying, and other specialities can be intensified in certain areas. Cotton will continue to be an important cash crop in the South, but not the only one.

3. *Conservation.*—To maintain opportunities for those left on farms, the productivity of land and its resources should be restored and maintained and watershed protection provided. Conservation measures of one type or another are required on all farmlands. Upstream flood-control measures are very important in this program. Bottom lands should be drained and put into production to relieve the pressure on the poorer hill soils. (See table 17.)

Forests must be rehabilitated and conserved by appropriate cutting methods, reforestation, stand improvement, fire protection, and sustained-yield management. (See table 18.) Many farmers should look upon trees as a crop. Industries should expand greatly on the basis of fuller utilization and conservation of timber resources.

Man-years of labor required to do this job total 885,000 on farmlands, and 383,000 on forest lands. In addition to these installations, 5,400 man-years will be required annually for the forestry program.

4. *Land-use control.*—In order to carry out this reorganization of farms and to conserve soils and forests, 12,400,000 acres of land should be publicly controlled, 11,000,000 acres in the Ozark-Ouachita area, and 1,400,000 in the Forested Coastal Plains (table 16).

Many families are trying to raise crops on lands much more productive if left in trees. The settlement of these lands brings only poverty to the settler and deprives the state and the community of the value of a productive resource. Legislation permitting public control of the classification and use of these resources is generally desirable. The state of Arkansas has already made great progress in this field.

5. *Employment.*—New opportunities for work in forest and recreation development. Through the development of markets for forest products to local industrial plants and in the expansion of commercial recreational facilities the farm people of this area may find full employment within the area. The forest products of the area when fully used in suitable processing and fabricating plants making consumer goods will provide a great opportunity for employment. Industries to use short lengths of the hardwoods may be established to make plywoods and laminated woods, etc., providing a market for timber now having no outlet. When such timber is profitable better forest management will result.

Further opportunities to earn a living in the rural areas will be provided in connection with the further development of the area for recreational purposes. These developments are outlined later under industry and recreation.

TABLE 16.—*Summary of adjustments, eastern area*

	Ozark-Ouachita	Forested Coastal Plains	Total
Present:			
Total area (acres)	46,526,000	23,441,000	69,967,000
Cropland (acres)	8,522,800	4,675,000	13,197,800
Nonfarm forests, etc. (acres)	15,823,000	12,061,000	27,884,000
Number of farms and ranches	255,600	134,000	389,600
Future:			
Purchased (acres)	11,000,000	1,400,000	12,400,000
Number of farms and ranches	158,600	90,000	248,600
Reduction in number of farms and ranches	97,000	44,000	141,000

TABLE 17.—*Measures to be installed and man-years of labor necessary for conservation of soils and water in the Ozark-Ouachita and Forested Coastal Plains subregions—Arkansas Valley (preliminary estimates)*

Measures and unit	Ozark-Ouachita [1]	Forested Coastal Plains [2]	Total
Acres, terraces	3,091,500	2,345,000	5,436,900
Acres, diversions	564,600	181,400	746,000
Acres, drainageway	235,000	189,000	424,000
Acres, contour furrows	3,402,000	1,130,000	4,532,000
Acres, pasture clearing	1,333,200	627,000	1,960,200
Acres, pasture planting	4,608,200	1,728,000	6,336,200
Acres, woody plantings	1,324,300	125,800	1,450,100
Acres, gully plantings	232,900	1,908,000	2,140,900
Miles, fence construction	67,800	30,800	98,600
Miles, highway grading	11,600	5,000	16,600
Miles, farm roads	53,900	24,300	78,200
Rods, gully diversion	1,550,400	9,510,000	11,060,400
Number, farm ponds	46,500	27,800	74,300
Number, stock water wells	22,000	19,500	41,500
Man-years of labor	432,000	453,000	885,000

Based on preliminary estimates of the Soil Conservation Service, U. S. Department of Agriculture.

[1] Includes Ozark plateau and some Loessal terrace and uplands and lands in Missouri of similar characteristics but not in the Arkansas River drainage basin.

[2] Includes some Loessal terrace and uplands.

NOTE.—Miscellaneous measures such as cutting posts, fence line clearing, stream-bank and highway planting, ditch construction, mulching, etc., not shown. Man-years of labor include necessary labor for these measures.

TABLE 18.—*Measures to be installed and man-years of labor necessary for conservation of woodlands in the forested subregions*

Measure and unit	Ozark-Ouachita	Forested Coastal Plains	Total
Acres, fire control	23,363,000	15,669,000	39,032,000
Acres, stand improvement	13,257,000	8,259,000	21,516,000
Acres, reforestation	2,556,000	1,091,000	3,647,000
Acres, erosion control	500,000		[1] 500,000
Acres, forest range improvements	6,472,000		6,472,000
Acres, recreational development	14,406,000	1,107,000	15,513,000
Acres, wildlife development	12,829,000	683,000	13,512,000
Acres, administrative improvements	14,340,000	1,107,000	15,447,000
Pounds, tree seed collection	445,000	512,000	957,000
Number, nurseries	19	10	29
Number, planting stock	[2] 1,869,450	[2] 1,035,760	[2] 2,905,210
Man-years of labor	213,000	170,000	383,000

Based on preliminary estimates of the Forest Service, U. S. Department of Agriculture.

[1] Also erosion control applicable to 7,500 miles of forest roads.

[2] 000 omitted.

WATER

The conservation, control, and utilization of water has played a large part in determining the present economic situation in the Arkansas Valley. Their future importance will be even greater with the development of a water program designed to serve the best interests of the people, land, and industry within the area.

The role which water plays, and the purposes it can best serve, vary widely over the Valley from the headwaters in the Rocky Mountains to the points of entrance into the Mississippi River. A broad index of the relationship of the water to the area is found in the quantity and characteristics of stream flow therein. In the upper reaches of the Arkansas and Red Rivers, where water is scarce, its capture and use for irrigation and water supply are essential. In the eastern part of the area, where water is plentiful, even overabundant, its control to prevent flood damages, to develop electric power, and to provide recreational facilities, becomes of paramount importance.

Stream Flow Characteristics

The Arkansas Valley includes three major river systems—the Arkansas, Red, and White River watersheds. The stream flow characteristics of these river systems have important differences.

The Arkansas River

The Arkansas River system drains 160,500 square miles and includes, in downstream order, these major tributary rivers: Purgatoire—3,390 square miles; Salt Fork—6,700 square miles; Cimarron—18,060 square miles; Verdigris—8,150 square miles; Grand (Neosho)—12,660 square miles; and Canadian River—47,500 square miles (North Canadian—16,850 square miles; South Canadian—30,650 square miles).

The headwaters of the Arkansas and South Canadian Rivers lie in the Rocky Mountains, where the loftiest peaks reach elevations of 14,000 feet. Here they are typical mountain streams, deriving most of their spring and early summer runoff from melting snow. Annual rainfall in the mountains varies from 10 inches in the sheltered valleys to as much as 40 inches or more near the range crests. On their downward course over the Eastern Slope of the Rockies, these streams pass through rough foothills where flash floods, occurring as a result of short but very intense periods of rainfall, are a characteristic of the area.

Continuing eastward, these rivers next traverse the High Plains, where the headwaters of the Cimarron and North Canadian Rivers are also situated. The combination of low rainfall, and poorly drained lands interspersed with sand hills, results in very small quantities

of surface run-off. Much of the rainfall over this area sinks into the ground or is lost by evaporation from the innumerable "playas" which have no surface outlet.

The main stream channels are in general wide sandy wastes, and both normal flows and floodwaters are largely dissipated through percolation into the valley alluvium. Thus the water courses are often dry for long periods of time.

An outstanding feature of this region is the "Canadian Breaks," a narrow, rough, broken strip of land cutting a gash through the High Plains—erosion caused by the South Canadian River.

Moving still further eastward, the rivers cross the Rolling Plains, where run-off characteristics change markedly. The terrain is both rolling and broken, and in general is well drained. Annual rainfall increases to 27 inches at the eastern boundary, and surface runoff, originating largely in flash floods, is much greater than that in the High Plains. Long periods of low flows are common. The river channels, retaining the character of those of the High Plains, absorb much of the runoff. The Cimarron River becomes highly mineralized in this reach through contact with natural salt beds. The area west of the eastern boundary of the Rolling Plains contributes very little to the floods of the lower Arkansas River; serious floods in the area originate east of this division, where run-off becomes progressively greater.

East of the Rolling Plains the watershed traverses the Central Prairies, the Cross Timbers and Flint Hills belt, and the Eastern Prairies. In these areas, the topography is a mixture of rolling prairie and broken hilly lands. The area includes the greater part of the Salt Fork, the lower Cimarron and Canadian Rivers, the Verdigris River and the greater part of the Grand (Neosho) River watershed. All of the stream systems are well developed and the surface is conducive to large and rapid run-off, especially in the Flint Hills and the Eastern Prairies. Long periods of low flows are common to the region. The Salt Fork is highly mineralized from natural sources, and the Arkansas River, receiving as it does the naturally polluted discharges of the Salt Fork and Cimarron Rivers, and of other minor tributaries, also becomes highly mineralized.

Leaving this region, the Arkansas River flows between the Ozark and the Ouachita Highlands. The northern tributaries, including the eastern Grand (Neosho) watershed, the Illinois River, and many smaller streams, drain the Ozark and Boston Mountains, while the southern tributaries, including the Poteau, Petit Jean, and Fourche La Fave Rivers, drain the Ouachita Mountains. A large run-off results from the high annual rainfalls. Run-off is erratic, however, due largely to short periods of intense precipitation, and during the hot summer months and at other times long periods of low flow are common.

The Arkansas River continues as a wide sand-bed stream to its mouth, disturbed at intervals by great floods originating over the eastern portion of its drainage area. Low flows, during which natural mineralization is high, are common.

Perhaps the most outstanding feature of the entire Arkansas River watershed insofar as stream flow is concerned is that the watershed above Garden City, Kans., constitutes a distinct and separate unit. Of the run-off originating in the upper basin, less than 15 percent in the form of flash floods and return flow from irrigation leaves the area at Garden City. This is largely the result of extensive use of stream flow for irrigation purposes. Flood flows in the upper reaches likewise have little effect on downstream discharges. During the record flood in the Upper Basin, which occurred in June 1921, the peak discharge of 200,000 c. f. s. just below Pueblo, Colo., receded to approximately 120,000 c. f. s. at the Colorado-Kansas State line and to only about 7,500 c. f. s. at Hutchinson, Kans.

The Red River

The Red River system within the Arkansas Valley comprises an area of about 83,000 square miles. It has two major tributaries, the Washita and Ouachita Rivers, draining areas of 8,100 and 16,800 square miles respectively.

The Red River headwaters lie in the high plains area. The low annual rainfall and the flat, poorly drained lands produce very little run-off. Twenty-five percent of the area drains into "playa" lakes and does not contribute to established stream systems. Long periods of zero flow are common.

The Red River leaves the High Plains through the Palo Duro Canyon in Texas and the watershed emerges onto the Rolling Plains at sharp escarpment extending across the eastern Panhandle region. The topoggraphy varies from rough and broken near the escarpment to gently rolling in the east. The surface drainage of this area is more highly developed than that in the High Plains, and physical conditions are conducive to greater surface run-off. Streams have cut into the red beds, a thick formation of fine to coarse-textured, poorly consolidated sandstone, shales, gypsum, and dolomite. Their erosion by surface run-off is responsible for the yellowish-red hue, especially noticeable during flood periods, from which the river derives its name. Contact with these red beds results in natural mineralization of most of the streams.

Continuing eastward, the Red and Washita Rivers next traverse the Cross Timbers region, where the Washita River joins the Red River. There is no marked difference in topography, but the land, hitherto open

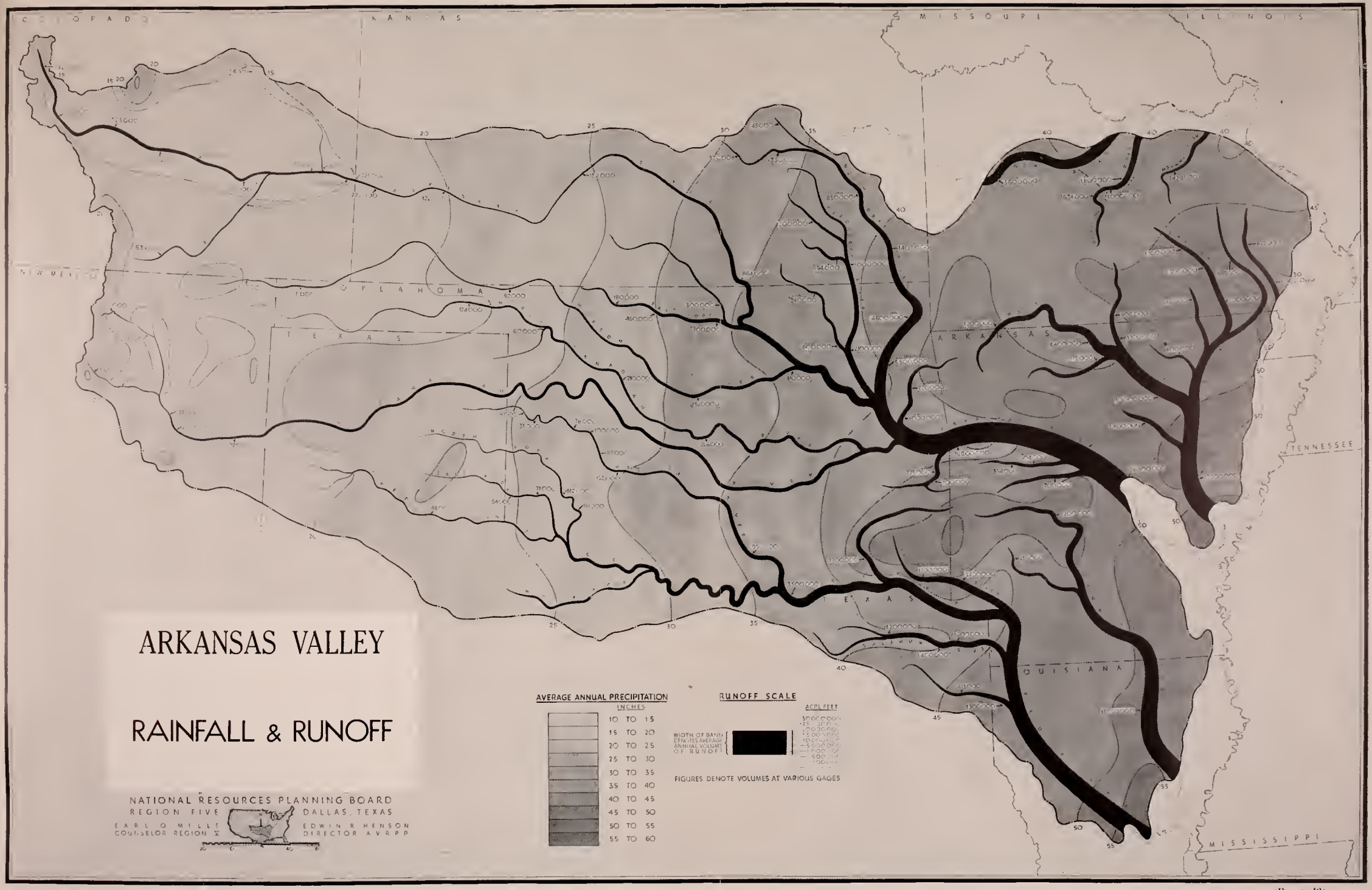


FIGURE 6.

(Face p. 42)

prairie, becomes thickly wooded. Rainfall increases, as does also the proportion of it which reaches the stream as run-off.

Emerging from the Cross Timbers area, the Red River flows through the Forested Coastal Plains of the west Gulf coastal plain to its junction with the Mississippi River. Drainage systems on these rolling plains are well established. The annual precipitation is high and flood flows of large volume are common and frequent. The rather wide alluvial bottoms bordering the Red River are very flat, and drainage is not well developed; hence, run-off is sluggish.

The headwaters of tributaries entering the Red River from the North, and adjacent to the Cross Timbers region, drain the southern slopes of the Ouachita Mountains. Run-off from this area is intense and rapid and can cause major floods in the lower Red River valley.

Near its mouth the Red River is joined by its principal tributary, the Ouachita River. This stream rises in the eastern part of the Ouachita Mountains with a well-developed drainage system and rapid run-off. The remainder of the watershed lies in the Coastal Plain area where run-off characteristics are very similar to those of the lower Red River. The bottom lands of the lower Ouachita River and many of its tributaries are very poorly drained and long periods of inundation have left them generally in a waterlogged condition.

The White River

The White River watershed within the Valley, comprising approximately 27,500 square miles, differs from the Arkansas and Red River basins in that it drains largely a homogeneous area wherein stream-flow characteristics are uniform.

About 85 percent of the area lies in the Ozark Highlands. The main streams in the highland area are entrenched deeply into water-bearing limestone, and there are large springs in the deeper valleys. As a result, the streams have a well-sustained dry-weather flow of cold, clear water. Many of the smaller streams are above the water-bearing limestones and are practically dry during the summer. Flood flows are frequent due to intense rainfalls common to the area. The lowland areas are composed of broad, level, alluvial valleys frequently flooded by run-off from the highlands. Rainfall over the basin varies from 44 to 52 inches annually.

Missouri and Mississippi River Drainages

The portions of the Osage, Gasconade, and Saint Francis River system within the region are typical Ozark streams. They are similar in character to those of the highland area of the White River basin.

Water Use and Control

The wide range of topographic and climatic conditions characterizing the Arkansas Valley creates an equally wide range in water problems and in the needs for water control and utilization.

The emphasis on these problems varies in character from the upper Arkansas River, where the retention and utilization of all available water for irrigation and water supply is essential to area development, to the lowlands of the lower Arkansas and Red Rivers, where, in places, excess water must be drained off rapidly and carried to the Mississippi River before the land can be utilized for purposes other than wildlife conservation.

Thus, within this Valley practically all of the problems of water use and control common to inland areas may be found. These include: conservation and use of surface run-off, and development of ground-water resources for irrigation and water supply; supplementation of water supplies by importation from adjacent watersheds; flood control by various means; development of hydroelectric power; abatement of pollution from domestic, industrial, and other sources; improvement of navigation by canalization and by dredging; recreation; drainage; erosion and silting; wildlife conservation; malarial control; adjustment of the present laws regulating use and control of water; and other more minor problems. Some of these problems are identified only with certain streams and areas; others are common throughout the entire area.

West of the 98th Meridian

In the area extending from the western boundary of the area to about the middle of Kansas, the need for utilizing all of the available water supply almost completely overshadows other features of water use and control. Here water is largely the limiting factor in the development of land and industry, and in attention to human comfort. The agriculture of the region, other than that dependent on irrigation, is necessarily of a type adaptable to conditions of low and uncertain rainfall.

The full utilization of surface water for irrigation is extremely important throughout the West, especially with respect to its stabilizing effect on the livestock industry. Water supplies for industries are difficult and expensive to obtain. In certain areas, notably the Arkansas River basin above Garden City, available water is now largely being utilized, and development of additional supplies through importation from other basins by transmountain diversion is necessary for the establishment of new water-consuming industries in that area. In other areas, industries using large amounts of water can be supported only at the expense of the water requirements of agriculture. During severe droughts, water supplies essential for domestic and stock consumption are lacking over wide areas, and water must be brought in by tank car and truck.

Despite this urgent need for water conservation

prairie, becomes thickly wooded. Rainfall increases, as does also the proportion of it which reaches the stream as run-off.

Emerging from the Cross Timbers area, the Red River flows through the Forested Coastal Plains of the west Gulf coastal plain to its junction with the Mississippi River. Drainage systems on these rolling plains are well established. The annual precipitation is high and flood flows of large volume are common and frequent. The rather wide alluvial bottoms bordering the Red River are very flat, and drainage is not well developed; hence, run-off is sluggish.

The headwaters of tributaries entering the Red River from the North, and adjacent to the Cross Timbers region, drain the southern slopes of the Ouachita Mountains. Run-off from this area is intense and rapid and can cause major floods in the lower Red River valley.

Near its mouth the Red River is joined by its principal tributary, the Ouachita River. This stream rises in the eastern part of the Ouachita Mountains with a well-developed drainage system and rapid run-off. The remainder of the watershed lies in the Coastal Plain area where run-off characteristics are very similar to those of the lower Red River. The bottom lands of the lower Ouachita River and many of its tributaries are very poorly drained and long periods of inundation have left them generally in a waterlogged condition.

The White River

The White River watershed within the Valley, comprising approximately 27,500 square miles, differs from the Arkansas and Red River basins in that it drains largely a homogeneous area wherein stream-flow characteristics are uniform.

About 85 percent of the area lies in the Ozark Highlands. The main streams in the highland area are entrenched deeply into water-bearing limestone, and there are large springs in the deeper valleys. As a result, the streams have a well-sustained dry-weather flow of cold, clear water. Many of the smaller streams are above the water-bearing limestones and are practically dry during the summer. Flood flows are frequent due to intense rainfalls common to the area. The lowland areas are composed of broad, level, alluvial valleys frequently flooded by run-off from the highlands. Rainfall over the basin varies from 44 to 52 inches annually.

Missouri and Mississippi River Drainages

The portions of the Osage, Gasconade, and Saint Francis River system within the region are typical Ozark streams. They are similar in character to those of the highland area of the White River basin.

Water Use and Control

The wide range of topographic and climatic conditions characterizing the Arkansas Valley creates an equally wide range in water problems and in the needs for water control and utilization.

The emphasis on these problems varies in character from the upper Arkansas River, where the retention and utilization of all available water for irrigation and water supply is essential to area development, to the lowlands of the lower Arkansas and Red Rivers, where, in places, excess water must be drained off rapidly and carried to the Mississippi River before the land can be utilized for purposes other than wildlife conservation.

Thus, within this Valley practically all of the problems of water use and control common to inland areas may be found. These include: conservation and use of surface run-off, and development of ground-water resources for irrigation and water supply; supplementation of water supplies by importation from adjacent watersheds; flood control by various means; development of hydroelectric power; abatement of pollution from domestic, industrial, and other sources; improvement of navigation by canalization and by dredging; recreation; drainage; erosion and silting; wildlife conservation; malarial control; adjustment of the present laws regulating use and control of water; and other more minor problems. Some of these problems are identified only with certain streams and areas; others are common throughout the entire area.

West of the 98th Meridian

In the area extending from the western boundary of the area to about the middle of Kansas, the need for utilizing all of the available water supply almost completely overshadows other features of water use and control. Here water is largely the limiting factor in the development of land and industry, and in attention to human comfort. The agriculture of the region, other than that dependent on irrigation, is necessarily of a type adaptable to conditions of low and uncertain rainfall.

The full utilization of surface water for irrigation is extremely important throughout the West, especially with respect to its stabilizing effect on the livestock industry. Water supplies for industries are difficult and expensive to obtain. In certain areas, notably the Arkansas River basin above Garden City, available water is now largely being utilized, and development of additional supplies through importation from other basins by transmountain diversion is necessary for the establishment of new water-consuming industries in that area. In other areas, industries using large amounts of water can be supported only at the expense of the water requirements of agriculture. During severe droughts, water supplies essential for domestic and stock consumption are lacking over wide areas, and water must be brought in by tank car and truck.

Despite this urgent need for water conservation

within the area, much surface run-off originating over the Cimarron, Canadian, Washita, and Upper Red River watersheds is wasted downstream through lack of adequate storage facilities, and undetermined reserves of ground water remain untapped. Facilities for insuring sufficient water supplies for domestic and stock consumption, both urban and rural, are inadequate, and the water available is sometimes unwisely used, requiring laws and education to guide its best distribution.

There are other water problems of lesser importance. Flood damage occurs throughout the area, being especially critical near the 98th meridian. Pollution of stream flow from oil field brines and wastes is severe on the Red River and several of its tributaries. Pollution from natural causes affects the quality of stream flow of the Red River and its tributaries, of the Cimarron River, and of the Salt Fork, although conditions on the Salt Fork have improved since completion of the Great Salt Plains Reservoir. With the exception of the mountainous area in the west, and a few small artificial lakes, water recreational facilities are almost completely lacking. Bank erosion causes extensive damage along most streams. Sand eroded from upstream areas has been deposited in the bottom lands of the Red, Canadian, Cimarron, and extreme upper Washita Rivers, destroying large areas of productive land. Large quantities of silt carried by the streams create problems in the maintenance of irrigation canals and structures and fill up space in reservoirs vitally needed for conservation and flood control.

In the upper area there are no possibilities of navigation, and the development of hydroelectric power is limited except as an incidental part of transmountain diversion. Here drainage is not generally important except as it relates to irrigation; to date, there are no problems of importance which have not been successfully solved.

East of the 98th Meridian

Here the emphasis on the relation of water to land, industry, and people in general is made from the point of view of control rather than of conservation, although there are a few instances where conservation is highly important. The normal water supply does not impose limiting conditions on the economy of the area; nevertheless, the control of water to prevent floods, to develop hydroelectric power, and to provide navigable streams and recreational facilities, is an essential part of regional progress.

Frequent floods are characteristic of the entire area, and cause extensive damage, chiefly to agricultural improvements. A total of 25 percent of all cultivated lands in this part of the Valley is included in the overflow plains of the many streams; these lands are generally considered the most productive in the area.

Although many of the most attractive water-power sites between the Mississippi River and the Rocky Mountains are located in this section, fewer than 10 percent of the potentialities have been realized. These potentialities lie almost wholly within the Ozark-Ouachita area.

Navigation is at present confined to intermittent traffic on the Arkansas River to Pine Bluff, Ark., on the White River to Guion, Ark., on the Red River to Shreveport, La., and on the Ouachita River to Arkadelphia, Ark., with dependable 6-foot navigation to Camden, Ark. The lower reaches of these rivers are all capable of being developed to permit dependable 9-foot navigation.

In the Ozark-Ouachita Highlands the mountains and streams present one of the most attractive recreational centers in the midwestern section. Maintenance and improvement of this area through the development and preservation of satisfactory stream-flow conditions is highly important to the Valley.

With the exception of streams in the Ozark-Ouachita Highlands, the water courses are in general highly polluted from domestic and industrial wastes, and from natural mineralization. Urban water supplies, although generally satisfactory, are often inadequate in periods of drought. There is a widespread lack of adequate rural water supplies. Rice irrigation in the Grand Prairie area has been over-developed and lowering of the groundwater level has become a serious problem, while in the nearby Oak Flat area extensive acreage is available for expansion of rice irrigation with adequate water supply. Control measures to avoid over development will be necessary.

Except in some of the larger drainage districts where refinancing has recently been worked out, organized drainage districts in the lower Arkansas, Red, St. Francis, and White River bottoms are almost universally in need of both financial and physical rehabilitation. Many levee districts also are in need of financial and physical rehabilitation. Other water problems of this area include the prevention of erosion and siltation, malarial control, and provision of satisfactory water legislation.

Control of water in the eastern half of the Arkansas Valley would result in many benefits to agriculture, industry, and to the people of the area. Flood control would increase the annual agricultural income by millions of dollars, new highly productive lands would be opened to cultivation, and a better economy would be possible for farm units partly comprised of bottom lands. The expansion of the Oak Flat rice irrigation area should also have a beneficial effect on agricultural economy.

Development of hydroelectric power, in conjunction with fuel power, will permit a more economical generation of electrical power in the area and thus assure low power rates attractive to industry. Stream channels that are capable of development for dependable 9-foot navigation may eventually be made navigable and thus provide for lower cost transportation of the bulk products of industry and agriculture. Water supplies, which can be developed satisfactorily throughout this area, are important to the expansion of industry. The provision of adequate water supplies for domestic consumption, the abatement of pollution, and the improvement of recreational facilities will all contribute to higher standards of health, sanitation, and leisure-time enjoyment.

Summary of Contemplated Improvements

Ideally, the ultimate objectives of a plan for the conservation, use, and control of the water resources of the Valley properly might be: provision of storage to permit use of all surface water occurring west of the 98th meridian for water supply and irrigation; development of the sustained capacity of all available groundwater supplies in that area; elimination of all flood damage; development of all potential hydro power; elimination of all stream pollution; and other important developments. However, physical and economic considerations inherent in such objectives make their complete attainment impracticable.

Under the plan herein proposed for the development and control of the water resources of the Valley, the following results would be achieved:

1. *Flood control.*—Available data indicate that, at present, annual flood losses of about $25,500,000 occur in the Valley. The contemplated flood-control program, including land treatment and runoff retardation measures, would reduce these annual losses to $12,900,000. Further reduction in losses may result from a satisfactorily administered flood warning service.

2. *Irrigation.*—At present, 694,000 acres in the western section are irrigated from surface water; more than 1,000,000 acres could be irrigated. Approximately 117,000 acres are now irrigated from groundwater. This can be expanded to at least 170,000 acres, with probable additional development following necessary test drilling.

3. *Hydroelectric power.*—At present an average of 460 million kw.-hr., or less than 7 percent of the hydroelectric power potentialities of the Valley, are produced annually. The program recommended provides for the annual generation of 3,175 million kw.-hr., or 43 percent of the Valley's known hydroelectric power potentialities. Additional hydroelectric power can be provided when the needs of the region demand.

4. *Navigation.*—Existing navigation is largely intermittent. Studies have indicated that the development of dependable 9-foot navigation on the Arkansas, Red, and Ouachita Rivers is physically feasible and that the savings in costs of transportations would either equal or closely approximate the costs involved. However, the need for, or wisdom of, providing such navigation at present is not clearly indicated, but decision should remain open for consideration as conditions change.

5. *Water supply.*—Urban water supplies that are now inadequate should be supplemented and a widespread program should be effected to provide rural domestic and stock water supply facilities.

6. *Pollution abatement.*—Extensive pollution abatement measures are recommended, including treatment of industrial and domestic wastes, satisfactory disposal of wastes from oil field and mining operations, and provisions to increase low flows through reservoir storage for dilution of wastes.

7. *Recreation.*—Small lakes for recreation, especially in the semi-arid central portion of the area, are recognized as a very desirable part of the water program. Conservation and recreation pools are included in all multiple use reservoir projects. Improvement of stream flow through increase of low flows, and elimination of pollution, will heighten the recreational values of the Valley's water courses.

8. *Other.*—Many other improvements in existing conditions of water use are possible, such as provisions for reduction of erosion and silting, rehabilitation of drainage districts, fish and wildlife conservation, malarial control by drainage and elimination of stream overflows, enactment of adequate water legislation, and other measures of somewhat lesser importance.

Background of Investigations

The feasibility of steps necessary to accomplish the improvements outlined have been studied by various Federal, State, and other agencies. They have been subjected to intensive analysis and discussion by five drainage basin committees of the National Resources Planning Board throughout the past 5 years. The work of these committees has to a considerable extent made possible the development of this water plan at this time.

In general, investigations made have been sufficient to support recommendations contained herein for development and control of the region's water resources. However, in many cases it has been necessary to go beyond present studies and to cover new ground in selecting measures that appear desirable and essential to the best development of the region when the relations between all factors influencing its future are considered.

Necessarily, only a broad picture of water conditions, proposed improvements, and their probable effects on the Valley can be given here. The watersheds of the Osage, Gasconade and St. Francis Rivers have not been considered in specific instances but only where generalities apply. Only the south central portion of the Osage River basin and the upper parts of the Gasconade and St. Francis River watersheds are included within the Valley. For intelligent consideration of water use and control it is essential that entire watershed units be encompassed.

Guiding Principles

As general guides in the selection of these measures for control and conservation of the waters of the area, three principles were followed, each of which involved a widespread regional concept of benefits. These principles affect flood control, irrigation, and small multiple-purpose reservoirs.

Flood Control

The benefits deriving from control of floods are regional in nature; they should be so evaluated and considered. In the eastern part of the Arkansas Valley, 25 percent of all cultivated lands lie in the highly productive overflow plains of the many streams, and flood damages to agricultural interests are extensive. The broad flood plains of the major tributaries are large enough to support entire farm units which are important sources of grains, feed crops, and other agricultural products upon which the economies of large adjacent areas are dependent.

On smaller streams, where the overflow areas are not so extensive, the bottom lands usually comprise parts of larger farm units. As these lands are often the only sections where cultivation is possible, successful operation of many farm units relies upon dependable production of the bottom-land areas. Thus, loss of crops through flooding entails not only the monetary losses but means that areas dependent upon the agricultural products of the bottom lands must import essential foods and fodder at increased costs, and that local canning, milling, and other industries also dependent upon this bottom-land production are adversely affected. In addition, by reclamation of additional bottom-land areas for cultivation through flood protection, much of the poorer uplands now in cultivation could be released for better use such as forest or grazing.

Under this regional concept of benefits, flood control assumes more importance than when considered in relation only to the areas directly protected. In agricultural areas such as the greater part of southern Kansas, where uplands as well as bottom lands are intensively cultivated, the regional principle is less pertinent; but in such sections as the Ozark-Ouachita highlands, where less than 20 percent of the entire land area is under cultivation, the principle is especially applicable.

The plan of flood control presented in this report has been derived largely from studies made by Federal agencies, which, it is felt, do not reflect wholly this regional concept of benefits. Quantitative studies would first be necessary to determine the importance of these indirect benefits before definite recommendations could be made concerning the ultimate degree of flood protection justified. However, some of the projects which have been included are based somewhat on assumptions of the results of future investigations. Other projects have been included which appear to approach economic justification closely from the standpoint of bottom-land benefits alone.

Closely related to the regional concept of flood control benefits are the adverse economic and social effects precipitated by the retiring of large areas from cultivation which certain reservoir projects involve. This is discussed under a subsequent section, "Floods and Their Control," in relation to a proposed series of Arkansas River reservoirs.

Irrigation

This is one of the most important single functions of water in the entire Valley. It should be adapted to contribute the greatest possible benefit to the regional economy.

West of the 98th meridian, agricultural economy and industrial development are limited by scarcity of water, and the best development of the area demands a full and careful utilization of all available water supplies.

The use of a limited water resource in growing high cash-income crops, which are often shipped out of the region for consumption in distant areas or placed in world-wide markets, is not wholly compatible with the best interests of the Valley from the long-range viewpoint. The most beneficial use of water for irrigating new lands would involve the growing of feed crops to stabilize the stock-raising and dry-farming industries and to provide a measure of insurance against loss of herds through lack of feed during drought periods.

Viewed from this regional aspect, projects that do not appear feasible under present practices, which offer no substitute for the incentive to grow high cash-income crops, may become justifiable and even essential to the best regional development.

Quantitative studies to determine the value of irrigation as related to the general regional development have not been made in this area and, although the principle has been recognized in this report as desirable in the consideration of irrigation, any projects relying thereon for justification should be thoroughly evaluated from this viewpoint before adoption.

While the above principle is ideally adapted to the upper Cimarron, Canadian, and Red River basins where many small irrigation projects are scattered widely over a large cattle-raising area, an exception must be made for the Arkansas River watershed above Garden City, Kans. Here are concentrated extensive tracts of irrigated lands devoted principally to the raising of specialty and high-cash-income crops. Irrigation practices in this area are long established and the economy of the entire upper Arkansas Basin has been built around these developments.

At present the quantity of feeds grown on irrigated lands in rotation with specialty crops is much greater than the demands of livestock raised on adjacent dryland areas. In addition to supplying the local demand, this feed and fodder is now used to fatten cattle imported from the western slope of the Rocky Mountains or is exported from the area.

If, as anticipated in this report, the cattle-raising industry of the western portion of the Arkansas Valley is expanded and stabilized, the future demands for feed and fodder grown on irrigated lands will be greatly increased. In time the local market may entirely absorb the present oversupply of these products in the Upper Arkansas Valley Basin and thus contribute to a more balanced economy than now exists.

Improvements proposed herein for irrigation in this area look toward the strengthening of the present economy.

Small Multiple-Purpose Reservoirs

The principle of the multiple use of a reservoir site for large projects is generally recognized and accepted as a satisfactory basis for control and conservation of stream flow. The principle has been recognized also in its relation to small reservoirs, but its application there has not been so wide.

There are several reasons for this. Large multiple-purpose projects are justified primarily upon the basis of readily evaluated benefits accruing to flood control, power, and irrigation, with incidental benefits to recreation, water supply, conservation, and other considerations. Small reservoirs must find a greater proportion of justification in the less tangible benefits of recreation, water supply, and conservation, with flood control, power, and irrigation being in many instances only of incidental importance and value, although they may in certain cases assume commanding importance.

Major Federal agencies responsible for investigating measures for the control and conservation of water have emphasized (1) the retention of water on the land in connection with soil conservation programs, or (2) the control of stream flow by large multiple-purpose reservoirs.

Between these two extremes lies the small reservoir on small tributaries which, due primarily to the local nature of benefits provided, has not been subjected to thorough analysis. In the few instances where small reservoirs have been considered, the criteria of design have been in general the same as those for large structures. The approach to the design of these small structures, especially in relation to spillway capacity, should be modified from that commonly employed in the construction of major projects, where failure would have disastrous results, to one which would reflect properly the economics of structural damage from failure. The hazards to downstream interests should, of course, be considered.

In the Arkansas Valley, particularly in the central section, the need for supplementing urban water supplies and water recreational facilities makes small reservoir projects most desirable. In the absence of full exploration of the possibilities of small reservoirs with regard to their multiple uses and their relation to the best future development of the region, it is not feasible to indicate in this report more than a generally desirable program, but their place in a comprehensive development must not be overlooked.

Floods and Their Control

Under present conditions, floods in the Valley cause estimated damages averaging $25,500,000 annually. This figure, although indicative of the over-all magnitude of flood conditions, is of much greater significance when separated into its component parts from several different approaches. Each of the following breakdowns is pertinent in the relation of flood damage to specific areas and to the region as a whole:

1. Arkansas River Basin—$11,700,000; Red River Basin—$7,500,000; White River and Ozark Basins—$6,300,000.
2. Agricultural damages—$19,500,000; other damages—$6,000,000.
3. Main stem damages—$15,400,000; small tributary and headwater damages—$10,100,000.
4. Damages west of the 98th meridian—$4,000,000; damages east of the 98th meridian—$21,500,000.

In the Upper Reaches

Flood damages west of the 98th meridian are confined largely to the main valleys of the principal streams, an exception being the upper Washita River Basin. The drainage systems in general are not well enough developed to cause excessive flooding of the smaller tributaries, and often the inundations that do occur are more beneficial than otherwise in their irrigational effects on feed crops and pasture.

Flood losses are not extensive, aggregating only $4,000,000 annually, which is due in large part to the irreparable destructive action of past floods in laying waste many thousands of acres of once-fertile bottom lands through deposits of sand and infertile silt. At

the time of original settlement in the Valley, the Cimarron, North Canadian, South Canadian, and upper Red Rivers east of the High Plains escarpment were narrow streams meandering through fertile bottom lands which were either heavily wooded or were covered with grass. Agricultural development, carried on without proper soil conservation practices, has resulted in enormous quantities of sand and silt being washed into the bottom lands of the major streams, changing completely the nature of the stream channels and of their adjacent lowlands.

In many places the channels of these streams are now shallow, sandy wastes more than a mile in width, and the bottom lands are dotted with sand and silt deposits which render large areas of them unfit for cultivation. Of an estimated 225,000 acres of bottom land subject to overflow along the main stem of the Cimarron River, a total of only 28,000 acres are under cultivation, the greater part of which is east of the 98th meridian. However, on the Arkansas River below Garden City, Kans., flooding has rarely occurred because of influencing physical factors and the extensive use of flood waters upstream for irrigation. As a result, the bottom lands have retained their natural characteristics and are intensively cultivated.

Although the portion of the Arkansas River basin west of the 98th meridian comprises over half of the total area of the watershed, run-off originating from this region is relatively unimportant in its contribution to flood flows of the lower Arkansas River. This is true also of the Red River system, although not to such a marked extent.

North Canadian River.—Two reservoirs, one under construction on the North Canadian River at Canton, Okla., and one practically completed on Wolf Creek at Fort Supply, Okla., are important units in a flood-control system for the North Canadian River. A third reservoir has been authorized on the North Canadian River at Optima, Okla. Recent studies have revealed that an alternate downstream site at Beaver, Okla., is more satisfactory, but that construction costs of both are at present too great for the benefits that would accrue to flood control alone. This reservoir system, although it reduces damages in the upper reaches of the North Canadian River, is justified largely by its prevention of flood losses on the stream east of the 98th meridian.

The three reservoirs are at present contemplated as flood control structures only, with provision for some storage at Canton for regulating low flows for dilution of pollution wastes. However, since the system was designed to provide complete control at Canton for a flood equal in magnitude to the greatest on record, it is felt that, without sacrificing flood control value to any great extent, a reallocation of storage in the reservoirs to permit utilization of part of their capacities for irrigation would result in greater over-all benefits. Studies have indicated that the desired storage for irrigation at Fort Supply, Okla., could be provided by effective reservoir operation without detracting from its flood-control function. This will no doubt prove true to some extent at the Canton reservoir. When considered as part of a system providing for both flood control and irrigation, the costs of the Beaver reservoir may not be unduly high when compared with the total benefits.

Washita River.—Exceptionally large agricultural flood losses occur in the entire Washita River basin. The sand movement characteristic of adjacent streams has in recent years become evident on the upper part of the river near Cheyenne, Okla. Unless checked, it will undoubtedly move downstream, devastating valuable bottom lands as it progresses. The proposed reservoir on the main stem near Foss, Okla., would form an ideal barrier to this sand movement. In addition to trapping silt and sand, such a reservoir would be important for flood control and irrigation.

The multiplicity in this basin of water problems and needs that can best be served by reservoirs—including flood control, irrigation, water supply, silt and sand detention, recreation, and pollution abatement by dilution of wastes—emphasizes strongly this means of solution. At least 30 other reservoir sites proposed for flood control, irrigation, and other purposes, have been investigated in the Washita River basin; however, all were found to lack economic justification.

But present studies have not considered all of these reservoir uses in their proper relation to the best development of the area. Detailed studies considering such uses in their proper relations will probably indicate the feasibility of several—perhaps many—reservoirs without which the full development of the basin is not possible. Accordingly, typical reservoirs in the Washita River watershed, not definite in number or location, have been included in the proposed program of improvements.

A levee project at Pauls Valley, Okla., and channel rectification measures at Chickasha, Okla., appear justified at present, but their construction should await a thorough investigation of reservoir possibilities.

Upper Arkansas River.—Except for a channel-improvement project at Colorado Springs, Colo., studies completed to date have not resulted in findings of feasibility for new flood-control projects. However, further studies of multiple-purpose reservoirs may show definite economic feasibility for provision of flood-control storage.

The investigations of the Colorado Water Conservation Board include reservoirs on all main tributaries and silt barriers on minor streams. These structures are needed, not so much to reduce damages from overflow, but to halt the disastrous processes of erosion and silt-

ing that, with increasing rapidity, are destroying valuable lands and property, including diversion facilities. In addition to control works on tributary streams, Colorado's program contemplates (*a*) extensive channel rectification along the main Arkansas River, and (*b*) special forms of land treatment and run-off retardation that will function under the relatively steep slopes of tributary catchment areas in foothills and plains regions where damaging floods originate.

Other areas west of ninety-eighth meridian.—Throughout the rest of the area west of the ninety-eighth meridian no projects are proposed herein primarily for flood control. Important flood reductions will accrue incidental to operation of reservoirs proposed primarily for irrigation, but, in general, benefits will be small due to lack of substantial flood damage in the bottom lands. The contemplated comprehensive land treatment and run-off retardation program will reduce flood damages by as much as 25 percent.

Further Downstream

East of the 98th meridian, flood losses are of much greater extent ($21,500,000 annually), and assume a greater importance in relation to agriculture. Although the estimated 13,000,000 acres subject to overflow represent only 13 percent of the total land area, the 6,000,000 cultivated acres which are subject to inundation represent 25 percent of the cultivated land in the region.

Of the total flood damage in the area, it is estimated that losses totaling $13,500,000 occur in the flood plains of the parent rivers and their principal tributaries, and losses totaling $8,000,000 occur in the bottom lands of small tributaries and headwater streams.

The problems of providing flood protection to reduce these losses are mainly the protection of bottom lands located along:

(a) The three major rivers;
(b) The major tributaries;
(c) The minor tributaries, and headwater creeks.

Investigations of possibilities for control of floods in areas of the first two classifications have been made in detail for the greater part of the Valley, and programs to provide flood protection have been determined. Little has been accomplished in studying means of alleviating flood losses in areas of the third classification by measures other than those which are included in land treatment and run-off retardation programs.

The floods of the lower Arkansas, Red, and White Rivers originate in widespread tributary systems; the water rises slowly, continuing at flood stage for days. The most feasible means of providing protection in each case is a combination of reservoirs controlling run-off from tributary areas and levees for additional protection in the broad, flat bottom lands.

The Arkansas River below the mouth of Cimarron River.—Protection from floods along the lower Arkansas River is now afforded by numerous levee systems, constructed by public or private enterprise, and by several reservoirs that have been built, or are being built, as the first units in a comprehensive flood control plan.

Below Little Rock, Arkansas, the levees are generally continuous and provide fairly adequate protection. Above Little Rock the levee systems are scattered and lack uniformity in degree of protection afforded. Proposed are new levees, or the improvement of existing levees, at 11 localities along the Arkansas River, 3 below Little Rock and 8 above.

Reservoirs, existing or under construction, that will have material effect in reducing lower Arkansas River floods include Nimrod on the Fourche La Fave River, Blue Mountain on the Petit Jean River, Canton on the North Canadian River, Pensacola on the Grand (Neosho) River, and Great Salt Plains on the Salt Fork of the Arkansas River. Proposed as additional units that are economically feasible and necessary to the comprehensive plan are 25 or more reservoirs which will reduce flood flows in the lower Arkansas River. The major projects included are Wister on the Poteau River, Tenkiller Ferry on the Illinois River, Ft. Gibson and Markham Ferry on the Grand (Neosho) River, Oologah and Hulah in the Verdigris River system, and Mannford on the Cimarron River. The remaining reservoirs are proposed primarily for tributary flood control but also for the incidental effect they would have in reducing flood flows on the Arkansas River.

This reservoir system will control all or parts of every major tributary that contributes substantially to lower Arkansas River flood flows. The major areas from which run-off would not be controlled include the lower Fourche La Fave, Petit Jean, and Poteau River basins; the lower Canadian River system; the lower Salt Fork River watershed; and the innumerable small drainage basins which empty directly into the Arkansas River between its mouth and Wichita, Kansas. With the possible exception of the Okmulgee reservoir on the Deep Fork of the Canadian River, there appear to be no major reservoir projects for control of additional tributary drainage area which would be economically feasible. However, tributaries entering the Arkansas River from the north in the State of Arkansas are in a heavy flood-producing area and although investigations to date have not found satisfactory sites for large reservoirs, some measure of flood control on these streams, in addition to that resulting from land treatment, should be achieved if possible. This might well be restudied with respect to small reservoirs under the policy previously suggested in this section.

Under the proposed program, it is estimated that

flood damages in the overflow plains of the lower Arkansas River would be reduced at least 50 percent in addition to flood losses prevented by existing flood remedial works.

The lower Red River.—The Denison reservoir, now under construction on the Red River just below the junction of the Washita River, will almost completely control flood run-off originating in the Upper Red and Washita River basins. However, damaging floods of major extent on the lower Red River can still originate from uncontrolled areas below Denison. A system of eight reservoirs—Durden Ferry on Bayou Bodeau, Black Bayou on Black Bayou, Narrows and Alikehi in the Little River system, Antlers on the Kiamaichi River, McGee and Tupelo in the Boggy Creek system, and Sandy Creek on the Blue River—are proposed to control run-off from a large part of this area.

Proposed also are five levee projects to supplement the existing extensive levee systems along the Lower Red River.

It is estimated that the proposed flood remedial measures will reduce flood damages along the Lower Red River by 88 percent.

The lower White River.—Existing flood control developments for the lower White River are similar to those for the lower Arkansas, consisting of private levee systems and of two reservoirs, Norfork on the North Fork and Clearwater on the Black River, both of which are under construction.

The reservoir program for the White River basin is primarily one combining flood control and power. The reservoirs proposed which would have important flood control value include Water Valley on Eleven Point River, Bell Foley on Strawberry River, Table Rock and Bull Shoals on White River, Gilbert and Lone Rock on Buffalo River, and Greers Ferry on Little Red River. Included also as desirable but needing additional investigation to establish their economic feasibility are Harviell on Cane Creek, Fairdealing on Little Black River, and Judsonia on Little Red River. This proposed system of reservoirs, including Norfork and Clearwater, would control run-off from over 50 percent of the White River watershed.

For additional protection of lowlands along the lower White River six levee projects are proposed.

The proposed program of reservoirs and levees for protection of the lower White River flood plain would reduce flood damages an esimated 65 percent; the greater part of the remaining damage would be that caused by backwater from the Mississippi River.

Major Tributaries.—Flooding of the major tributaries of the parent rivers results either from heavy, intense storms; from long, general rainfalls; or from combinations of both. The most important method of protection is by reservoir control, although levees and channel improvements are desirable at certain localities.

Grand (Neosho) River.—Investigations have established the economic feasibility of a system of at least three reservoirs in the Upper Grand River for control of floods and other purposes. Two of these reservoirs, at Marion and Council Grove, Kansas, are recommended for construction although investigations now being made may suggest a larger alternate reservoir in the vicinity of Marion, controlling also a larger portion of the drainage area. The economic propriety of smaller reservoirs on the tributaries of the Cottonwood River may also be suggested. The third reservoir that appears feasible is on the Grand River at either Iola or Strawn, Kansas. Present indications point to the Strawn site as the more desirable.

Such a reservoir system is justified largely by benefits which would be derived within the Grand (Neosho) River Basin. The existing Pensacola and proposed Markham Ferry and Fort Gibson reservoirs on the lower Grand (Neosho) River in Oklahoma derive flood control benefits almost entirely from protection afforded to lands along the Arkansas and Mississippi Rivers.

Verdigris River. — Six reservoirs — Toronto, Fall River, Elk City, Neodesha, Oolagah, and Hulah—controlling 61 percent of the Verdigris River drainage area, are authorized for flood control and other purposes. The first four reservoirs are justified primarily by benefits obtained in the Verdigris River valley, while the latter two are justified in large part by benefits derived in the bottom lands of the Arkansas and Mississippi Rivers. Runoff from the 39 percent of uncontrolled area can still cause extensive damage along tributaries of the lower Verdigris system and along the lower Verdigris River itself. This 39 percent of uncontrolled drainage area has not been subjected to the detailed study given to the rest of the area; however, adequate investigation will probably indicate the feasibility of several reservoirs in this section of the basin.

Included in the proposed flood control plan for the Verdigris basin, in addition to the six authorized reservoirs, are typical reservoirs in the lower basin, not definite in number or location, but believed to be indicative of what further investigation will prove feasible.

Walnut, Ninnescah, and Chickaskia Rivers and Slate Creek.—The Walnut River basin has not been investigated for flood control since a general study of the entire Arkansas River basin was made in 1930. Recent studies completed on adjacent basins with many similar characteristics indicate that reservoir systems are economically feasible. On the strength of this, it is believed that detailed investigation of the Walnut River basin similarly would indicate a reservoir system justifiable for flood control and other purposes.

Accordingly, typical reservoirs, not definite in location or number, have been included in the proposed plan of watershed development.

This applies equally to the Ninnescah and Chickaskia Rivers. In like manner, typical reservoirs have been included on these streams. A typical reservoir is indicated on Slate Creek for protection of lands along the Arkansas River.

Arkansas River, Tulsa to Hutchinson.—Proposed improvements for protection of the Arkansas River from Tulsa, Okla., to Hutchinson, Kans., include the reservoirs discussed in connection with the Walnut, Ninnescah, Chickaskia Rivers, and the Slate Creek area, the authorized Mannford reservoir on the Cimarron River, and six levee and/or channel improvement projects, including improvements at Hutchinson and Wichita, Kans., Tulsa and Kaw, Okla., and two rural areas.

Lower Cimarron River.—Flood damages along the lower Cimarron River are not of sufficient magnitude to justify flood control works.

Lower North Canadian River.—While the proposed reservoir system for the Upper North Canadian River should provide a high degree of protection to bottom lands along the lower North Canadian River, it would not afford enough protection for Oklahoma City, principally because uncontrolled runoff between Canton, Okla., and Oklahoma City could still cause floods. A levee system and floodway for that city has been investigated and found justifiable.

A reservoir at Okmulgee, Okla., on the Deep Fork River has been investigated and reported as not economically feasible. However, the reservoir was designed to control a flood 15 percent greater than the maximum on record. A reservoir designed for somewhat less capacity would provide benefits almost as great, and when other factors of water conservation, such as recreation and water supply, are evaluated, a ratio of benefits to costs might indicate adequate justification. Accordingly, the Okmulgee Reservoir has been included in the program as desirable, pending future investigation to establish its feasibility.

As construction of the Okmulgee Reservoir would require acquisition of a large area of highly productive bottom lands, a program of intensive land treatment in the basin plus several small headwater reservoirs might accomplish the desired degree of flood protection without involving purchase of valuable bottom lands. This appears to warrant investigation as an alternate to the Okmulgee Reservoir.

Lower South Canadian River.—The usual type of flood damages along the lower South Canadian River are insufficient to justify remedial works. However considerable loss of land from bank caving is believed to warrant additional study of this condition.

Ouachita River.—The flood problems of the Ouachita River basin have recently been investigated in detail. The bottom lands along the principal streams of this basin are for the most part heavily wooded; along the Ouachita River below Camden, Ark., only 4 percent of the flood plain has been cleared and put into cultivation. This is due largely to soil characteristics which do not permit satisfactory drainage, resulting in large areas of continually water-logged land. Extensive and costly drainage structures would be necessary for successful cultivation.

The remedial measures included in the proposed program will not greatly reduce Ouachita River floods below Camden, but will provide a high degree of protection above that point. The two reservoirs proposed, the Blakely Mountain and Narrows projects, are combined flood-control and power projects, with power carrying a large share of the justification. Five channel improvements on tributaries of the Ouachita River, and a levee project at Calion, Ark., are also proposed.

The Lower Washita.—The discussion of flood control for the upper Washita River basin applies equally to the lower watershed, except that storage for irrigation is not feasible at this time.

Other major flood control improvements.—Several projects mentioned above only in reference to control of floods of the Lower Arkansas, White and Red Rivers will provide important flood reductions and benefits along tributary streams. The Wister reservoir would reduce floods of the lower Poteau River; Bell Foley, Water Valley, Fairdealing, and Harviell reservoirs would control floods of the Black River; and Sandy Creek, Tupelo, McGee, Antlers, Alikchi, and Narrows reservoirs would provide substantial protection to Boggy Creek and to the Blue, Kiamichi, and Little Rivers.

Flood control capacities.—The capacities of various proposed reservoirs have been determined as those necessary to control a flood equal in volume to the greatest on record; in cases where this was not practical the maximum physical site capacities were selected. Apparently, analyses of smaller capacities have not been made, nor have economic comparisons been drawn. In many instances the optimum economic flood control capacity for a given reservoir is somewhat less than that required to control completely a flood equal in magnitude to the greatest on record, and a restudy of present proposed capacities with this in view would be worthwhile.

Minor stream flood control.—Flood damages that occur along small tributary and headwater streams of the Valley are estimated to aggregate $10,000,000 annually, of which $8,000,000 occurs in the eastern section. Flash floods produced by short rainfalls of high

intensity are characteristic of the great majority of these streams, and it is in the reduction of such floods that land-treatment programs for run-off retardation are most effective, especially in the western area. In many instances, future investigations may prove that small multiple-purpose headwater reservoirs are feasible for the further reduction of these damages. However, due to their widespread occurrence on the many thousands of small tributary streams and brooks, it is doubtful if reservoir protection will ever affect more than a small percentage of the total area concerned.

Present investigation of main-stem Arkansas River reservoirs.—Under investigation at present by the Corps of Engineers, United States Army, is a reservoir for flood control and power on the Arkansas River above Ft. Smith, Arkansas, and three hydro-power projects between Little Rock and Ft. Smith, Arkansas. This reservoir system would almost completely control floods on the lower Arkansas River, would provide over two billion kw.-hr. of electrical energy annually, and would inundate an area of over 400,000 acres, of which almost 250,000 acres are considered among the finest agricultural lands in the Arkansas Valley.

The social and economic implications involved in retiring this land from agriculture would be far-reaching, and would not only entail dislocation of the economy of the immediate region but would extend at least 25 miles on each side of the river, affecting an area as large as the State of New Hampshire.

To some extent, many of the reservoirs included in the proposed comprehensive system for protection of the Valley depend for their justification upon benefits to be derived in the very reaches of the Arkansas River which would be inundated by these four main-stem reservoirs. Construction of the reservoirs might cancel the justification of upstream projects and thus prevent their construction. This would spread the undesirable economic consequences of the Arkansas River reservoirs over an even greater area.

Studies of these reservoirs have not been carried to a sufficient degree of completion to indicate what the ratio of benefits to costs may be. If this ratio is favorable but without an outstanding preponderance of benefits to costs, it surely should not be considered as a desirable part of the Valley's development. If a very favorable ratio of benefits to costs is apparent, it is still highly questionable whether the reservoirs should be constructed, and a detailed analysis should be made, comparing the advantages of power generation with the advantages of retaining in cultivation the bottom lands that would be affected, and comparing as well the relations of the two alternatives to the best development of the entire area.

Summary of Flood Control Program

At the end of this section there may be found a list of all proposed projects having flood control value (table 19). These projects represent a comprehensive plan for reduction of flood damages along the principal streams of the Valley, although additional protection may appear justified if quantitative analysis of the regional benefits of flood control is made. Future unpredictable developments in the flood plains may indicate as desirable protection of areas not now economically justified.

Proposed flood-control measures would reduce annual flood damages along the main streams from $15,400,000 to $6,400,000. Reduction of flood damages along minor streams would be accomplished principally by land treatment and run-off retardation measures. Small reservoirs, none of which is specifically proposed, would contribute to additional reductions. Eventually, annual flood losses on small streams may be reduced from $10,100,000 to $6,500,000.

The over-all flood-control program would result in reduction of annual flood damages in the Arkansas Valley of from $25,500,000 to $12,900,000. Through flood protection many hundred thousand acres of bottom land could be cultivated which now either lie idle or are devoted to pasture because of frequent flooding; this would increase the agricultural productivity of the region and permit desirable adjustments involving the retirement of hillside areas from cultivation. In addition, the proposed reservoir system would be effective in the reduction of Mississippi River floods and would derive appreciable benefits therefrom.

Irrigation

One of the most important single functions of water in the entire Valley is its use for irrigation. At present, approximately 811,000 acres are irrigated annually within that part of the area west of the 98th meridian, of which 694,000 acres are irrigated from surface supplies and 117,000 acres from ground water.

There remain large areas of which the uncontrolled run-off would lend itself to irrigation if storage for excess flows were provided, and huge reserves of undeveloped ground water that could successfully be used under wise development.

Surface-Water Irrigation

Arkansas River Basin above Garden City, Kans.—In the Arkansas Valley above Garden City approximately 550,000 acres are now being regularly irrigated, about 490,000 acres being in Colorado, and the remainder in western Kansas. The water supply upon which this irrigation depends is derived almost wholly from sur-

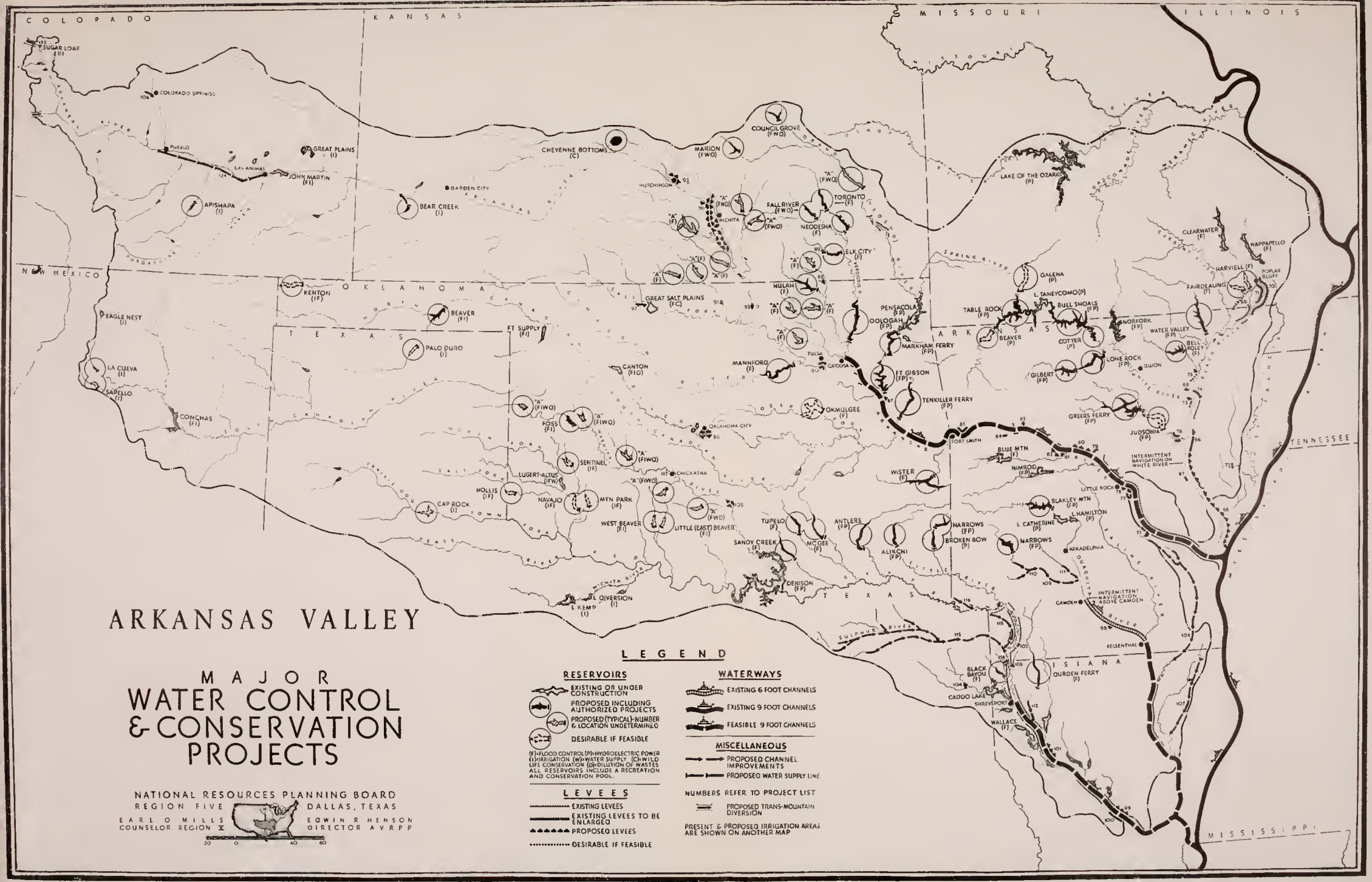


FIGURE 7.

(Face p. 52)

face run-off, originating in the mountains and on the plains of southeastern Colorado; it has averaged about 1,150,000 acre-feet annually during the past 30 years.

Due to inadequate storage, to the allowing of unregulated water to escape and thus to serve no useful purpose, and to the large overappropriation of river flow, chronic shortages of irrigation water are now existent that affect a large part of the total acreage under irrigation. Only the ditches under the oldest priorities have any assurance of an adequate supply.

The total available water supply, except for flood-peak flows in excess of the capacity of diversion works, and the return flows which enter the stream below point of diversion, is practically all used within the basin. Under present conditions, the outflow has averaged about 170,000 acre-feet annually. It is anticipated that upon the completion of John Martin Dam (Caddoa), these wastes may be reduced by about half, thus providing for more complete utilization.

The major problems for which solutions are urgently needed in connection with the use of water in the area involve the following:

1. The importation of additional water from the Colorado River Basin, this supplemental water to be used first to eliminate the chronic shortages now existent;

2. The regulation of existing supplies to afford their more complete utilization;

3. The possible salvage of water now serving nonbeneficial uses;

4. The settlement of pending interstate litigation.

Toward the alleviation of these problems, proposed projects include supplementation of the present water supplies by the importation of water subject to the economic and physical limitations of this and surrounding basins. Two sources of available water and the probable amounts therefrom are:

From Colorado River tributary	To Arkansas River tributary	Amount of diversion—Acre-feet
Frying Pan	Lake Fork	40,000-70,000
Gunnison	South Fork	250,000-280,000

Such importations involve replacement storage on the Western Slope of the Rocky Mountains and regulation storage above the head of irrigation in the Arkansas Valley. The availability of storage sites on the western slope is not a limiting factor. On the Eastern Slope sites for the development of adequate storage are more expensive. The enlargement of Sugar Loaf Reservoir on Lake Fork from 17,300 acre-feet to about 90,000 acre-feet is proposed for the complete control of any importations from the Frying Pan River. Definite locations to control diversions through South Fork have not been selected pending completion of surveys now in progress.

Incidental to the transmountain diversions, the development of hydroelectric power is anticipated. Several proposals have been made for this use of increased water supply through existing plants, and the development of available head through the construction of new plants. Estimates of the amount of hydropower that may be developed must await studies not yet completed.

The construction of Bear Creek Reservoir and Apishapa Reservoir are recommended for the regulation of existing water supplies. These two reservoirs, with their combined capacity of about 80,000 acre-feet, will affect only a minor part of the total regulation required for complete control. Although other sites studied have not been found justified for conservation or flood control only, further studies may indicate economic feasibility for multiple-purpose development—flood control, silt retention, and conservation—such that a substantial portion of the storage needed for complete control may be realized. Possible reservoir projects in this category are: Purgatoire River above Trinidad, Huerfano River near Cucharas River Junction, and Purgatoire River near its mouth.

The settlement of the interstate litigation now pending over the distribution of the Arkansas River between Colorado and Kansas is urged at as early a date as possible. All attempts at an amicable settlement have so far failed. Before full development can take place, this controversy, which has gone on almost continuously since 1901, will have to be resolved.

Arkansas River below Garden City.—In this area, which includes the Arkansas River and minor tributaries below Garden City, 30,000 acres are at present irrigated from surface run-off and valley alluvium. Investigations have indicated that the topography makes reservoirs unfeasible. However, there are possibilities of utilizing water supplies from alluvium for irrigation, and development is proposed for 12,000 acres along Pawnee River, and 14,600 acres along the Arkansas River.

Cimarron River Basin.—In the headwater section of the Cimarron River Basin, 11,250 acres are irrigated annually, most of which takes place by direct flow diversion. At present a project (Settlers Ditch) for the irrigation of approximately 5,000 acres near the Oklahoma-Kansas State line, by direct diversion from the Cimarron River, is being reconstructed as a Water Facilities project.

Small water supplies and lack of inexpensive reservoir sites have mitigated against large projects for the storage and utilization of Cimarron River flows for irrigation. Below the Salt Plains the quality of water in the Cimarron River is not suitable for irrigation. Investigations have revealed but one major site (at Kenton, Okla.), with possibilities for economical de-

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velopment, and this only from the stand-point of benefits to the region as a whole. It is included among the proposed projects subject to determination of its feasibility in relation to the regional economy. Based upon meager stream-flow data, it is estimated that 16,000 acres can be irrigated.

North Canadian River.—Existing surface-water irrigation developments in the North Canadian River watershed comprise only 1,350 acres. By utilizing storage in reservoirs under construction and contemplated for the control of floods, and by other scattered developments, irrigation projects appear feasible which would make use of practically all of the available surface-water supply of the upper North Canadian watershed. Storage can be made available in the reservoir system without materially affecting its flood-control value, and greater over-all benefits would result therefrom. Consideration of irrigation in connection with flood control may indicate that a reservoir at Beaver, Okla., should be added to those under construction at Fort Supply and Canton, Okla.

The program proposed for development of irrigation in the North Canadian River Basin includes provision of 8,000 acre-feet at Fort Supply and 50,000 acre-feet at Canton, to irrigate 3,500 acres and 18,000 acres respectively. A reservoir at Beaver could support an irrigation development of 6,000 acres.

A small reservoir on Palo Duro Creek appears desirable to supply storage for irrigating 3,200 acres, and is included in the program pending investigations sufficient to establish its economic feasibility.

Withholding flood flows for gradual release, in combination with return flows from upstream irrigation projects supplied by reservoir storage, would increase materially the water supply that could be used for downstream irrigation along the river, and make irrigation feasible. Developments which could be supported by direct diversion of surface flow, supplemented by pumping from the alluvium, are estimated to total 11,000 acres and would be scattered along the entire upper river.

The above program provides for the irrigation of a total of 41,700 acres, which, and when combined with other water demands in the upper basin, would effectively utilize practically all of the surface-water supply available in the upper basin. Allowances have been made in the program for water supply for development of additional municipal and rural needs, for stock ponds, and for small impoundments to serve miscellaneous purposes.

South Canadian River.—At present 71,200 acres are irrigated from surface water in the South Canadian River, all of them in New Mexico and all but 1,800 acres located above Conchas Reservoir. The Arch Hurley project now under construction will utilize conservation storage in the Conchas Reservoir to irrigate 45,000 acres. With completion of this project, most available run-off above Conchas Dam will be utilized. Investigations of storage sites to control and conserve run-off from areas below Conchas have indicated that such storage would be too costly for major irrigation developments. Thus it appears that completion of the Arch Hurley project will exhaust the possibilities for major irrigation projects in the South Canadian River watershed. However, there is indication of the possibility of some small scale developments here, and further investigation of their feasibility is needed.

Of the existing irrigated areas above Conchas, many receive their water supply from direct diversion of uncontrolled run-off. Two projects are included in the program to control and supplement existing supplies in this area, the La Cueva and Sapello Reservoirs, both in the Mora River watershed. The former is definitely proposed, and the latter is indicated as desirable if investigations establish its justification.

Upper Red River Basin.—Existing irrigation from surface water in the Upper Red River basin is limited to a few scattered tracts along various tributaries and to the Wichita Falls development on the Wichita River, a storage project supplying irrigation water to an average of 28,000 acres annually. At this project, sufficient water supply is available and storage provided to support an estimated additional 52,000 acres of irrigable land. The Lugert Altus Reservoir, now under construction on the North Fork, provides for a primary supply to irrigate 20,000 acres, and a supplementary supply for 50,000 acres.

There are many other sites in the basin where supplies and storage possibilities will permit development of irrigation if physical and economic conditions are found to be satisfactory. The streams of the upper Red River system are in general highly mineralized. Investigations on the Pease River indicate that the quality of water of that stream, in combination with the nature of soils of the irrigable lands, may not permit successful irrigation. On the other hand, run-off from the Wichita River is being used and it appears that the run-off of the North Fork will support irrigation.

Sufficient data on the quality and quantity of run-off on other tributaries are not available to indicate whether successful irrigation could be practiced or to determine the acreage that could be supplied. Until these data are obtained, intelligent decisions concerning the possibilities of irrigation cannot definitely be made. Investigations conducted on the assumption that water supplies of satisfactory quality were available indicated that projects heretofore studied would not be justified. However, if benefits were evaluated

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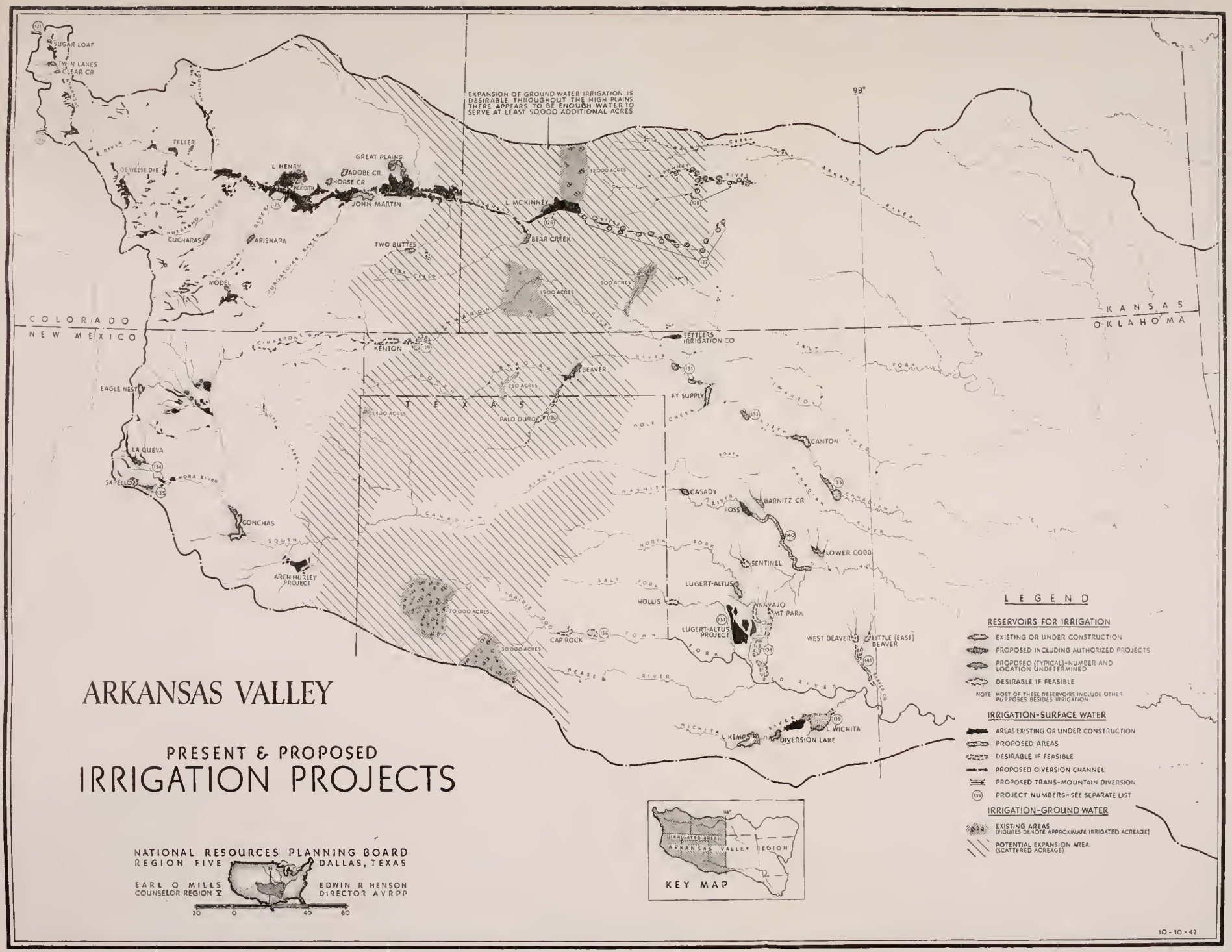

FIGURE 8.

(Face p. 54)

on a regional basis, several projects might prove feasible, physical conditions permitting.

To indicate generally the magnitude of possible developments, the following projects have been included in the proposed program, subject to a determination of their feasibility from the viewpoint of both their economic importance and the suitability of water supply:

Project	Stream	Acres irrigated
Cap Rock	Prairie Dog Town Fork	4,500
Mangum	Salt Fork	(1)
Navejo	North Fork	
Sentinel	Elk Creek	28,500
Mountain Park	Otter Creek	
West Beaver	West Beaver	4,400
Little Beaver	Little Beaver	3,400

[1] Supplement Lugert Altus.

All of these reservoirs, with the exception of Cap Rock, would provide important flood-control benefits.

During the past 10 years an average of only 28,000 out of a possible 80,000 acres have been irrigated under the Wichita Falls development. Distribution facilities to accommodate 43,000 acres have been constructed. There appear to be many conflicting indications concerning the success of this project, but the extension of irrigation facilities here recommended should make possible the full utilization of water supply consistent with the best interests of the area. An investigation of its development from its inception in 1925 should prove of great value in considering other irrigation projects in the upper Red River Basin.

Washita River.—Irrigation has not been practiced to an appreciable extent in the Washita River Basin. The upper basin lies at the eastern fringe of the area, where irrigation to produce feed crops for stock-raising is considered desirable. The exceptionally heavy flood damages that occur throughout this watershed indicate a combination of flood control and irrigation as the major functions of reservoirs in the western part of the basin. Included as part of the proposed Foss project is provision for storage to supply irrigation water to 25,000 acres. Provision for irrigation storage in the proposed typical reservoirs for the western part of the basin is also contemplated.

Small-scale irrigation.—Irrigation of small, scattered, individual tracts of land by surface storage is highly desirable. Where physically and economically feasible, this should be undertaken through private enterprise or through public agencies such as are provided by the Water Facilities Act. Care should be taken to control such developments in areas where water supply for existing major downstream projects might be jeopardized.

Summary of surface-water irrigation.—Projects for irrigation included above provide for the development of over 200,000 acres of irrigated land, in addition to supplemental supplies for existing irrigated areas. Projects under construction provide for irrigation of 120,000 acres, making a total of over 320,000 new acres that may be irrigated in the future.

This may be increased possibly as much as 25 percent by construction of numerous small-scale irrigation projects.

Ground-Water Irrigation

Extensive ground-water irrigation is confined almost entirely to the High Plains. Throughout much of this section, rather large bodies of ground water occur in the Tertiary sands and gravels which form the plains mantle and range in thickness from about 100 to 400 feet.

While these deposits, which collectively are known as the Ogallala formation, can with few exceptions be depended upon to furnish adequate supplies for domestic purposes, they do not always supply water in sufficient quantities for extensive irrigation. The feasibility of developing irrigation water supplies from them depends upon complex geologic, economic, and agricultural factors which must be considered if intelligent planning of the water resource is undertaken. Particular attention must be given to the relation between withdrawal and recharge, which determines the safe dependable yield of the ground-water reservoir. Specifically, this depends on the capacity of the reservoir and the amount of annual recharge.

Throughout the High Plains the hydrologic conditions governing the amount and availability of ground water for irrigation purposes vary widely. Great differences may be noted in total thickness of the formation, depth to water, porosity and permeability, and thickness of the water-bearing column. Hence, the propriety of new irrigation development is to a great extent dependent on the results of test-well operation. In areas where the depths to water are within the economic range for irrigation pumping, and where the water-bearing formation has not been seriously thinned by erosion, test wells and pumping tests should be provided.

One of the most serious factors to consider in connection with both present and future well irrigation on the High Plains is that of ground-water control. At the present time, with the exception of New Mexico, no effective legislative control exists in the area governing the withdrawal of water and the spacing of wells. Ground water held in the Ogallala sands and gravels is in a state of transient storage and is exhaustible. Its recharge comes entirely from local precipitation and is therefore limited. It is evident that a sound plan for irrigation use of these water resources should include some form of legislative control which limits the amount of withdrawal, controls the spacing of wells, and in general promotes a more efficient and dependable water use.

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Extensive ground-water irrigation is confined almost entirely to the High Plains. Throughout much of this section, rather large bodies of ground water occur in the Tertiary sands and gravels which form the plains mantle and range in thickness from about 100 to 400 feet.

While these deposits, which collectively are known as the Ogallala formation, can with few exceptions be depended upon to furnish adequate supplies for domestic purposes, they do not always supply water in sufficient quantities for extensive irrigation. The feasibility of developing irrigation water supplies from them depends upon complex geologic, economic, and agricultural factors which must be considered if intelligent planning of the water resource is undertaken. Particular attention must be given to the relation between withdrawal and recharge, which determines the safe dependable yield of the ground-water reservoir. Specifically, this depends on the capacity of the reservoir and the amount of annual recharge.

Throughout the High Plains the hydrologic conditions governing the amount and availability of ground water for irrigation purposes vary widely. Great differences may be noted in total thickness of the formation, depth to water, porosity and permeability, and thickness of the water-bearing column. Hence, the propriety of new irrigation development is to a great extent dependent on the results of test-well operation. In areas where the depths to water are within the economic range for irrigation pumping, and where the water-bearing formation has not been seriously thinned by erosion, test wells and pumping tests should be provided.

One of the most serious factors to consider in connection with both present and future well irrigation on the High Plains is that of ground-water control. At the present time, with the exception of New Mexico, no effective legislative control exists in the area governing the withdrawal of water and the spacing of wells. Ground water held in the Ogallala sands and gravels is in a state of transient storage and is exhaustible. Its recharge comes entirely from local precipitation and is therefore limited. It is evident that a sound plan for irrigation use of these water resources should include some form of legislative control which limits the amount of withdrawal, controls the spacing of wells, and in general promotes a more efficient and dependable water use.

At present, approximately 117,000 acres in the Valley are irrigated from ground water. This does not include areas irrigated by water recovered from alluvium, which is considered a surface-water source, nor does it include the area devoted to rice irrigation in the eastern portion of the region. The existing irrigation is concentrated largely in two areas: one of 30,000 acres and one of 70,000 acres (Hereford area) both in the Texas Panhandle near the southern border of the Valley. The rest is scattered throughout the High Plains.

The Hereford area, comprising parts of Deaf Smith, Castro, and Randall Counties, Tex., has experienced rapid and uncontrolled expansion within recent years, enlarging from 40,000 acres under irrigation in 1939 to 70,000 acres in 1941. This uncontrolled expansion has caused lowering of the ground water levels which, although moderate, has affected a large area and indicates that a large amount of water has been withdrawn from storage in the underground reservoir. Further uncontrolled expansion will eventually affect adversely the entire area. Legislation to establish means of controlling withdrawals in this area is urgently needed.

Throughout the rest of the High Plains there are large areas where potential ground-water reserves are known to exist. Sufficient information is not available upon which to base recommendations as to extent and definite locations for development. However, it is felt with certainty that there are sufficient supplies to serve at least 50,000, and probably many more, additional acres. Expansion of ground-water irrigation in these areas should occur only on a sound progressive basis after test drilling has located adequate supplies and established their safe rate of sustained yield.

Ground-water irrigation in the Rolling Plains offers negligible possibilities.

Small garden irrigation is desirable throughout the entire western region. At most farmsteads, even in the Rolling Plains, adequate supplies can be found to accomplish this.

Rice Irrigation

Irrigation of rice is practiced in two large areas in the easternmost part of the Valley, these being the Grand Prairie area situated in east central Arkansas between the lower Arkansas and White Rivers, and the Crowley Ridge (Oak Flats) area which lies in northeastern Arkansas, between the White and St. Francis Rivers.

The Grand Prairie area covers 640,000 acres, of which 450,000 acres have been adapted to rice irrigation. In past years an average total of 125,000 acres has been irrigated annually. The water supply comes principally from underground sources, supplemented by some surface impoundments. The demand on the underground supply has caused a serious overdraft and a recession of the water table has occurred which varies from 10 to 15 feet at the outer edge to as much as 65 feet in the center of the region. Investigations have indicated that provision of additional surface supplies in important quantities through impoundments cannot be justified economically. However, the proposed reservoirs for flood control and power will result in material increases in the low flows of the White River which would provide a logical source of supply for supplementing present ground-water reserves.

The Crowley Ridge (Oak Flats) region comprises 1,500,000 acres, of which 97,000 acres in rice were irrigated from ground water in 1942. The overdraft on ground-water supplies has not become serious, and there appear to be available supplies sufficient to more than double the present rice irrigation without serious consequences.

The State of Arkansas has no ground-water legislation, but such legislation is urgently needed to restrict further immediate development, to control and conserve the existing ground-water supplies, and to guide the expansion of areas devoted to rice irrigation when supplemental White River supplies become available. It is strongly recommended that the immediate steps necessary to secure such legislation be taken.

Water Supply

The characteristics of surface and underground waters, the two major sources of water supply, vary widely throughout the Valley, and consequently conditions governing quantity and quality of water available for domestic, farmstead, and industrial uses are also widely divergent. Conditions, limitations, and proposals for improvement of water supply for these three uses are different in many respects.

Urban Domestic Supply

Those municipal water supplies in the upper Arkansas River Basin which are derived from surface run-off of the mountain areas, or from ground water (which occurs in ample quantities only in spotted locations), are in general satisfactory.

The upper Arkansas River and its alluvium is a source of supply for several cities and towns along its course; and, although supplies are ample below Pueblo, Colorado, they are of very inferior quality due to hardness, turbidity, and pollution. Several small towns on the north side of the river, namely, Ordway, Olney Springs, and others, have developed the springs emerging from the north hill lines for their supply. The water is of a good quality but limited in quantity, allowing but a few gallons per capita per day. This is used only for human consumption, necessitating dual systems to furnish water for fire fighting, watering of lawns, and other

purposes. Other communities have developed deep-well supplies which in general are of poor quality and expensive to obtain. There is a definite need for improvement of urban water supply facilities in this area.

High Plains.—Here ground water is the primary source of municipal supply and in general is satisfactory in both quantity and quality but the presence of fluorine in sufficient concentration to cause tooth enamel mottling is critical in several areas, especially in the Texas and Oklahoma Panhandle regions.

East of the High Plains.—In this area, which extends from the High Plains to the Ozark-Ouachita Highlands and the West Gulf Coastal Plains, subsurface conditions in general are not conducive to the occurrence of satisfactory ground-water supplies.

In the southern half of this area, especially in the upper Red River watershed, Permian "red beds" are exposed over the surface, deposits which ordinarily yield only small quantities of highly mineralized water. Scattered throughout the area are local geologic formations that normally yield satisfactory water supplies, although they are not generally dependable in periods of drought. Several ground-water fields that ordinarily would provide satisfactory water supplies have been so polluted by oil-field brines that they are unfit for domestic use.

The rivers and streams of this region are widely used for municipal water supply but long periods of drought result in low or zero flows and cause severe shortages. In the southern section many of the streams are naturally highly mineralized and badly polluted by domestic, industrial, and oil-field wastes. Stream flow in general is of inferior quality, requiring extensive treatment for domestic use.

The river alluviums are an important source of supply, although water thus derived is often of poor quality and not dependable during drought periods. Especially severe drought shortages are chronic at cities and towns such as Vernon, Crowell, Quanah, Electra, and Burkburnett in the upper Red River Basin; on numerous occasions essential water supplies for human and stock consumption have been hauled in by truck and by tank car.

In the northern half of the area, stream flow is in general of better quality, although some water courses have become so badly polluted by domestic and industrial wastes that cities once utilizing these streams have been forced to develop other sources of supply. Streams included in this category are the North Canadian, Deep Fork, Walnut, and Spring Rivers. Drought periods impose critical conditions. Flows of both the Grand (Neosho) and of the Verdigris Rivers are so extensively used for public water supply that during periods of extreme low flow the sewage effluent of one municipality comprises the bulk of water supply of the adjacent downstream community.

The most satisfactory source of urban water supply in the general area under discussion and the one employed by the great majority of larger cities is surface water impoundment. These supplies are usually of fair quality, and where sufficient storage is provided, the quantity is ample to withstand drought periods. Many cities utilize surface impoundment as a reserve supply to supplement other sources of normal supply. The only solution to the water supply deficiencies of towns in the southern part of the area appears to be impoundments on nearby tributaries selected for the lowest probable mineralization.

Ozark Highlands.—This section is characterized by the best sources of water supply of any area of the Arkansas Valley, other than those on the eastern slope of the Rocky Mountains. Satisfactory supplies can normally be obtained from the major streams or from deep wells, although often this water is hard. Ground water is not available in the Ozark area of Northwestern Arkansas. Streams which are not spring-fed or which lie above water-bearing rock formations are often dry in periods of drought.

Ouachita Highlands.—Here only small amounts of ground water are available and during dry periods tributary flows are intermittent, resulting in a lack of readily available water over most of the area. There is a definite need for water facilities development such as small reservoirs for water supply, or for regulation of flows into minor streams.

West Gulf Coastal Plain.—Ground-water reserves underlying this area, are generally satisfactory sources of community supply.

Lower Arkansas and Red Rivers.—These are both extensively polluted by natural mineralization, domestic sewage, oil-field brines, and other industrial wastes, and are unfit for most domestic uses. Because of the natural mineralization of these waters, it is doubtful that even if other sources of pollution were eliminated, they would be satisfactory for domestic use.

Lower White River.—The extensive withdrawals of ground water for the irrigation of rice in the Grand Prairie Region have seriously encroached upon the water supply source of several communities in this region. Legislation regulating future use of the ground-water reserve is urgently needed.

The Valley as a whole.—Throughout the entire Valley many communities exceeding 500 in population, and a number with population of more than 1,000 people, do not have public water-supply systems. The individual wells supplying the family units in these towns are often subject to contamination, and undesirable sanitary conditions are common.

Industrial Water Supply

The conditions governing industrial water supply are in general similar to those affecting domestic municipal supply. However, there are important limitations with respect to industrial water supply that are not pertinent to urban supply.

Arkansas River above Garden City, Kansas.—The entire existing water supply in this area is appropriated many times over, and there is a chronic shortage for irrigation needs. Under present conditions, water supplies for new water-consuming industries, or for expansion of present ones, are obtainable only through the difficult and expensive procedure of purchasing water rights which now serve irrigation, and transference of these rights by legal action. This would involve a curtailment of water supplies now used for irrigation, and is not in the best interests of the region's development. Importation of water by transmountain diversion from the Colorado River Basin appears to be the only satisfactory solution for permitting limited development of additional water-consuming industries in this area.

High Plains.—Throughout this section the limited water supply available makes it essential that, in the best interests of the area, this water be conserved and utilized for domestic and agricultural purposes. A water-consuming industry or group of industries requiring 30,000,000 gallons of water daily—not an excessive amount for many industries—would use enough water annually to irrigate at least 30,000 acres.

Coincidental with most industrial developments are concentrations of urban population which would make additional demands on underground water reserves in the high plains. There are exceptions where, for physical reasons, water supplies are available that are not usable for agriculture, but these are limited and relatively unimportant. A case in point would be the flow of the South Canadian River through the Canadian Breaks, where arable land is not available. In general, the use of water in the High Plains region for industry should be carefully weighed against its alternative use for agriculture, and the relative benefits to the region from both uses should be determined before establishing water-consuming industries.

Remainder of the Valley.—Water supply for industry in the Valley east of the High Plains is a limiting factor only locally, and affects definite site selection rather than regional placement. Condenser water supply for fuel-burning electric generating plants is an important factor governing expansion of existing facilities and location of new plants.

Rural Water Supply

Throughout the entire Valley there is a general lack of facilities for developing existing water supplies to serve normal farmstead and livestock needs, and for storing water to carry the Valley through drought periods. In the High Plains satisfactory ground-water supplies are almost universally available, but facilities are inadequate for developing and utilizing these supplies, especially in relation to storage and location of watering centers for stock.

In the area east of the High Plains, excluding the Ozark-Ouachita Highlands and the Gulf Coastal Plain, surface and ground-water supplies are unreliable, and widespread shortages during droughts are common due to lack of carry-over storage facilities. In the Ozark-Ouachita Highlands, water-courses occurring above the water-bearing rock formations are often dry during the long hot summers. Shallow ground-water supplies are scarce, and deep wells are too costly for the average farm unit. Provisions are urgently needed for storage of surface flows to carry over dry summers, or deep wells to insure community needs. In the Gulf Coastal Plain area, ground water is usually available and the lack of farmstead and livestock facilities is not critical.

Proposed Program for Improving Water Supply

A comprehensive program for improvement of present domestic, farmstead, and industrial water supplies, and for elimination of chronic deficiencies, can be indicated at present in general terms only. The needs and possibilities of fulfillment of each community, farm unit, and industrial demand would have to be analyzed individually before a detailed program could be formulated. However, in general, such a detailed program should contemplate:

1. Improvement of the quality of stream flow and the reclamation of certain streams as a satisfactory source of supply through the program for pollution abatement herein set forth.

2. Supplementation of existing urban and industrial supplies by development of new ground-water fields, or by surface impoundments. Highly desirable, especially in the central portion of the Valley, are small reservoirs on selected streams combining water supply with provisions for recreational development and other uses.

3. Additional treatment facilities for municipalities whose present water supplies are of inferior quality.

4. Provision of public water supply systems, where lacking, for towns with a population in excess of 500 persons.

5. Provision of adequate farmstead and livestock water supply facilities. This may be accomplished on individual farm units by providing stock ponds, windmills for pumping ground or surface water, water tanks, and other facilities. Deep wells, or small reservoirs for storage, to serve community farm needs and to regulate low flows for downstream users may be desirable solutions in many cases.

6. Legislation providing for regulation of groundwater use.

7. Maintenance of drinking water standards defined by the United States Public Health Service throughout the region.

Specific proposals for improving existing water supplies which can be made now are:

1. In connection with the proposed importation of water by transmountain diversion into the upper Arkansas River for irrigation and power, a pipe line from Pueblo, Colo., to Las Animas is recommended to provide a water supply of satisfactory quality to municipalities and industry located along that reach of the Arkansas River. Importation of water would make available sufficient additional supplies, after shortages for agriculture are made up, to permit the minor expansion of industry in the upper Arkansas Basin here contemplated.

2. Storage capacity should be provided in the proposed reservoirs of the upper Grand (Neosho), Verdigris, and Walnut Rivers to insure adequate water supplies to water users along these streams.

Pollution

Pollution of the natural watercourses of the Arkansas Valley varies between wide limits. The streams of the Ozark-Ouachita highlands flow through heavily wooded, sparsely settled hills where undesirable discharges into the drainage system are few and the resultant quality of water is excellently suited to recreational uses. The upper watersheds of the Cimarron and Canadian River system are sparsely settled also, and the streams receive few pollutional wastes.

Elsewhere in the Valley, however, pollution of the watercourses in varying degrees of seriousness is characteristic of the present stream flow. Many streams that once provided water supplies for human consumption, supported fish life, and offered numerous recreational opportunities, now carry heavy loads of domestic sewage, industrial wastes, silt, brines from oil fields, acid mine wastes, and oil refinery discharges and are thus rendered unfit for any other purpose.

Domestic Wastes

Treatment of domestic wastes by municipalities throughout the Valley differs broadly in its adequacy, and, because developed largely through independent efforts, exhibits little relation to a desirable program for securing and maintaining satisfactory stream flow conditions.

State policies, although ill-defined, have in the past to some extent influenced the general discrepancies in the degree of treatment which exist between States. Present State policies are much more aggressive and, largely through activities of the Arkansas Valley Drainage Basin Committees of the National Resources Planning Board, uniformity of objectives in treatment of pollutional wastes has begun to materialize.

The treatment of domestic sewage in sufficient degree to eleminate objectionable conditions is an objective of modern communities throughout the country and should be accepted in the Arkansas Valley both as desirable and as possible of accomplishment.

Industrial Wastes

Streams in the Valley are polluted by many varieties of industrial wastes, the most important being those from oil refineries, creameries, canneries, packing plants, and pulp and paper mills. Satisfactory means of treatment or disposal of wastes have been developed for most industrial processes, and industry in general has come to accept satisfactory treatment of its wastes as a necessary and normal part of its operating costs. There is no reason why this should not hold true for all industry within the Valley.

The discharge of salt brines, resulting from oil-field operations into the streams of this region, is one of the most important sources of pollution. Oil fields located in the Texas Panhandle and in downstream areas of the Red River grossly pollute the Red River and many of its tributaries. This is true also of the lower North Canadian River, the Deep Fork of the North Canadian River, the Cimarron River, the Walnut Creek, lower Verdigris and Grand Rivers, and the entire lower Arkansas River. Satisfactory disposal of operating oil-field brines by reinjection and by other methods has proven highly successful in reducing pollution from this source in southeastern Kansas and from fields north of Oklahoma City and has illustrated the practicality of avoiding this nuisance.

A widespread program to solicit, or, if necessary, to compel cooperation of oil-field operators in disposal of oil-field brines is a proper and necessary step in the development and control of the Valley's water resources. Drainage of old, improperly plugged wells contributes greatly to pollution by salt brines and offers a problem difficult of solution since the locations of many abandoned wells are not known. Although much expense would be involved in finding and plugging these old wells to eliminate this source of pollution, it is believed such expense can be justified.

Acid wastes from coal and metal mines cause particularly severe pollution of the Spring River (Grand Neosho Basin), the lower Poteau River, and the upper Petit Jean River. Although no completely satisfactory method for disposal or treatment of these wastes has been developed, much can be accomplished by proper operation and by sealing of old mines to reduce the nuisance created.

The rapid expansion of dairy and canning plants in southeastern Kansas, northeastern Oklahoma, and western Arkansas in recent years has resulted in a considerable increase of stream pollution in that area. Adequate treatment should completely eliminate pollution from these sources.

Natural Mineralization

Natural mineralization of streams from contact with salt and gypsum beds and with soils of high mineral content is an important source of stream pollution in the Arkansas and Red River Basins.

The Salt Fork of the Arkansas River derives its name from its exceptionally high salt content which, however, has been declining since completion of the Great Salt Plains Reservoir. The Cimarron River flows through an extensive salt flat near the middle of its course and becomes highly mineralized from that point on. Below the junction of the Salt Fork, the Arkansas River carries a high mineral content and is considered by many to be unfit for most domestic or industrial uses. The tributaries of the upper Red River and also the Red River itself are highly mineralized from contact with the "red beds" of the upper watershed. Nothing can be done to improve this condition materially, and it must be accepted as a natural characteristic of the streams affected.

The heavy silt loads carried by most streams of the Valley must be considered a source of pollution in their adverse effect on domestic and industrial water supplies and on recreational uses. The total program of land use for the area will do much to reduce this pollution source.

Setting Standards of Water Quality

The complete treatment of all domestic and industrial wastes in the various watersheds is neither required nor expected. A departure from the natural pristine quality of stream flow is to be expected as a condition of human habitation and industrialization of a region. However, certain standards of water quality can be set, based on intensity of development, natural quality of water, quantity of stream flow, and other factors which should insure against objectionable conditions and indicate the highest quality of stream flow which is both practical and economical of attainment.

The basic data relating to existing quality and quantity of stream flow are inadequate for a detailed classification indicating standards which could be met for many streams in this area. However, based upon the limited information available and upon judgment of individuals intimately acquainted with the pollution problems of the region, the Subcommittees on Pollution of the Arkansas Valley Drainage Basin Committees have recommended classification of the major streams in the Valley into three categories, each indicative of a quality of flow which it is believed could reasonably be attained. These classes and the standard each sets are:

Class I.—Streams of this class must be acceptable for domestic water supply with treatment. They must be able to support all recreational uses, including bathing.

Class II.—Streams of this class must be acceptable for domestic water supply, although extensive treatment may be required. They must also support fish life, but need not be suitable for bathing.

Class III.—Streams of this class must create no objectionable conditions. They need not support fish life nor be suitable for recreational purposes.

It so happens that virtually all streams included under Class III in this study are primarily unfit for most uses because of natural mineralization, although other considerations would indicate this classification in certain instances. In this connection, it is believed a separate designation indicating mineral content is desirable.

Proposals for Improving Stream Flow Quality

To obtain the stream flow qualities indicated in the above classifications, the following measures are proposed:

1. An extensive program for providing the necessary treatment of domestic sewage. This includes additional treatment facilities and improvement of present operation, which in many cases does not take advantage of otherwise satisfactory existing plants. The degree of treatment required cannot be indicated from data at hand; it will depend primarily upon the volume of pollutional discharge and the magnitude of sustained low stream flows, and will vary from the removal of solids by primary treatment to complete treatment and disinfection of plant effluent.

2. A program similar to the one outlined above, involving treatment of industrial wastes.

3. A comprehensive program soliciting (or compelling, if necessary) cooperation of operators of oil fields and coal and metal mines in disposal of oil brines and reduction of acid mine wastes, including the plugging of old wells and sealing of abandoned mines that are causing trouble.

4. Provision of effective State legislation and for coordinated administrative practices through which the above programs could be enforced.

5. Inclusion wherever feasible of storage in reservoirs for dilution of wastes. This is proposed in the general reservoir plan for projects on Grand (Neosho), Verdigris, Walnut, North Canadian, and Washita Rivers.

6. Provision generally of sewer systems and sewage

ARKANSAS VALLEY
PROPOSED PLAN FOR
STREAM PURIFICATION
NATIONAL RESOURCES PLANNING BOARD
REGION FIVE
DALLAS, TEXAS
EARL O MILLS
COUNSELOR REGION V
EDWIN R HENSON
DIRECTOR AVRPP
LEGEND
PROPOSED STREAM CLASSIFICATION
SYMBOL CLASS MINIMUM STANDARD
I MUST BE SUITABLE FOR ALL RECREATIONAL PURPOSES AND FOR DOMESTIC WATER SUPPLY FOLLOWING TREATMENT
II MUST SUPPORT FISH LIFE AND BE SUITABLE FOR DOMESTIC WATER SUPPLY ALTHOUGH EXTENSIVE TREATMENT MAY BE NECESSARY
III NEED NOT SUPPORT FISH LIFE OR BE SUITABLE FOR WATER SUPPLY BUT MUST NOT CREATE NUISANCE
EXISTING POLLUTION SOURCES
DOMESTIC SEWAGE - ADDITIONAL FACILITIES NEEDED
DOMESTIC SEWAGE - BETTER OPERATION OF EXISTING FACILITIES INDICATED
CITIES OVER 5,000 - PRESENT TREATMENT ADEQUATE
INDUSTRIAL WASTES - TREATMENT NEEDED
INDUSTRIAL WASTES - PRESENT TREATMENT ADEQUATE
OIL FIELD WASTES - TREATMENT NEEDED
MINE WASTES - TREATMENT NEEDED
NATURAL SALT POLLUTION - NO TREATMENT POSSIBLE
POPULATION SCALE
1,000 - 3,999
4,000 - 9,999
10,000 - 24,999
25,000 - 49,999
50,000 - 99,999
OVER 100,000
THE INFORMATION FOR THIS MAP WAS OBTAINED IN COOPERATION WITH THE VARIOUS STATE SANITARY ENGINEERS AND PUBLIC HEALTH OFFICIALS THROUGH THEIR ASSOCIATION WITH POLLUTION SUB-COMMITTEES OF THE NRPB DRAINAGE BASIN COMMITTEES.
COLORADO
KANSAS
MISSOURI
ILLINOIS
NEW MEXICO
OKLAHOMA
TEXAS
ARKANSAS
LOUISIANA
TENNESSEE
MISSISSIPPI

FIGURE 9.

(Face p. 60)

treatment plants for all communities above some specified size, possibly those having a population of 750 persons.

It should be understood that stream classifications made in this report are based largely on judgment. A program is recommended to obtain sufficient quantitative data reflecting quality and quantity of stream flow upon which to base a more detailed classification of streams, and to indicate desirable standards of sewage treatment.

Hydroelectric Power

This subject is covered fully in the section on power below.

Navigation

Commerce and navigation on the Arkansas, Red, Ouachita, and White Rivers originated during the early period of settlement of the Arkansas Valley, the rivers supplying the only means of through transportation.

Navigation flourished on these rivers, reaching a peak about 1872, when railway development began in the area. Subsequently, water transportation declined until—with the exception of that portion of the Ouachita River extending from its mouth to Camden, Ark., in which dependable 6-foot navigation has been provided—it is at present of very little importance. Intermittent navigation for boats of shallow draft is now possible on the Arkansas River to Pine Bluff, Ark., on the Red River to Shreveport, Louisiana, on the Ouachita River above Camden to Arkadelphia, Ark., and on the White River to Guion, Ark.

Interest has been revived in recent years in making provision for a modern permanently improved channel for year-round navigation on these rivers, with facilities comparable to those on the Ohio and Upper Mississippi Rivers. Studies indicate that, under the present freight rate structure, the savings in transportation costs through provision of navigable channels of 9 feet in depth on the Arkansas, Red, and Ouachita Rivers would equal or closely approach the annual carrying charges.

Past investigations have indicated that, because of the character of these streams, dependable navigation can be obtained only by the construction of locks and dams. The project which appears most desirable for the Arkansas River involves a route from the Mississippi River via a short section of the White River, thence by short canal to a point below Yancopin, Ark., on the Arkansas River, thence in general by the main stem of the Arkansas River to the mouth of the Verdigris River, and thence up the Verdigris River to Catoosa, Okla., which is 15 miles from Tulsa, Okla.

The most practical project for the Red River appears to be a lateral channel bypassing the main stem from the mouth of the Ouachita River to Shreveport, La. The Ouachita River Project would involve improvement of the existing 6-foot channel to provide 9-foot navigation to Felsenthal, Ark.

These navigation projects are included as part of the possible development of rivers of the Valley, but not as definite proposals. An adjustment of freight rates in this area to lower levels would result in an unfavorable showing of savings through navigation in relation to its cost. However, the industrial program contemplated in this report might increase the demand for low-cost transportation of raw materials within the Valley sufficiently to affect materially this relation.

The need for, or wisdom of, providing 9-foot navigation on the Arkansas, Red, and Ouachita Rivers in the near future, at a cost which would approximate anticipated savings, is not clearly indicated at this time. However, with continuation of present freight rates, or with an increase in rates, consideration of navigation developments must remain open as conditions affecting traffic movements change.

Recreation

Water in natural watercourses, lakes, or in artificial impoundments universally has many highly valued recreational uses. In the Arkansas Valley west of the 98th meridian the scarcity of water for recreational uses increases immeasurably the value of the existing few facilities. East of that line, specifically in the Ozark-Ouachita Highlands, water is largely responsible for its development into one of the most popular mid-continent resort regions.

Western Area

The eastern slope of the Rocky Mountains included within the Valley is characterized by typical mountain streams offering many recreational opportunities. Other than the construction of a few reservoirs for water conservation, little activity is necessary here to create more attractive advantages for water recreation.

Eastward over the High Plains the watercourses are often dry, natural lakes are few, and opportunities for creating artificial lakes are very limited. This is an area where natural physical conditions will always limit development of water recreational facilities and should be accepted as such.

Between the High Plains and the Ozark-Ouachita Highlands natural stream flow is not well suited to recreational pursuits, and there are not many natural lakes. Possibilities for providing water recreational facilities now lacking are the greatest of the entire Valley. A number of small artificial lakes have been created, some for their recreational value alone, but most of them in connection with impoundments for water supply.

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Between the High Plains and the Ozark-Ouachita Highlands natural stream flow is not well suited to recreational pursuits, and there are not many natural lakes. Possibilities for providing water recreational facilities now lacking are the greatest of the entire Valley. A number of small artificial lakes have been created, some for their recreational value alone, but most of them in connection with impoundments for water supply.

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It is not uncommon, on a hot summer week end, to find hundreds of people congregated around one of these treeless artificial lakes for the sheer enjoyment of being near water. This appeal of water to the average individual places a high value on the development of these facilities.

Investigations made of reservoirs in this area by various Federal agencies have recognized the recreational needs of the region and the importance of water in fulfilling them. In general, this function has not been evaluated and the policy followed appears to provide for inclusion of a recreation and conservation pool if a reservoir for other purposes is justified. However, the need goes further than this, and full evaluation of recreational facilities would probably indicate that they might properly bear a larger portion of the total cost. This is pertinent especially to the small type of reservoir; therein lies the real possibility of developing greater water recreational facilities.

Ozark-Ouachita Highlands

This area, with its combination of natural forest cover and clear, flowing streams, presents a landscape of exceptional recreational value. The streams are noted for the fine fishing, boating, and swimming they offer, and the region as a whole is ideal for camping, hiking, hunting, and many other outdoor pastimes.

In the best interests of the Arkansas Valley, recreational advantages in this area should be maintained and improved wherever possible. The system of reservoirs contemplated for flood control and power will change the characteristics of many streams from natural-flowing water courses to a series of level pools. This will in turn adversely affect existing water recreation developments of these streams, but if reservoirs are operated in part in the interests of recreation, alternative types of recreational use can be provided which may be of equal or greater value. To accomplish this it is essential that pool fluctuation be kept at a minimum and that suggested minimum standards of downstream flow be maintained.

The natural flowing stream provides many recreational advantages which are not associated with natural or artificial lakes. Because of the present recreational importance of the Ozark-Ouachita area, deriving principally from its flowing watercourses, it is desirable and justifiable to maintain at least one major stream of the region free from artificial impoundments. The stream proposed as ideal for this purpose is the Current River, a tributary of the White River system. Hydropower and flood-control possibilities in this basin are not believed to be of outstanding merit; moreover, the Current River is one of the most attractive streams in the entire Ozark area. In similar cases where power and flood control are not of commanding importance, it would seem desirable to maintain as many streams as possible in their natural regimen of flow.

Gulf Coastal Plains

The lowlands of this area are heavily wooded and are characterized by many natural lakes. Good hunting and fishing opportunities abound, in addition to other natural recreational pursuits. In the hillier section of the area, small reservoirs for recreation and other purposes have been constructed. There is a need for additional structures of this type.

Lower Arkansas and Red Rivers

Pollution of these rivers, largely from natural sources, has damaged the recreational value of these streams. It does not therefore appear feasible ever to expect improvement of the quality of this water sufficient to permit extensive use for recreational purposes other than boating and fishing.

Conservation Pools

Included in each reservoir proposed for flood control, power, irrigation, or other purposes is a conservation and recreation pool. In general, stream flow below proposed reservoirs will be enhanced for recreation through reduction of flood flows and improvement of low flows. Although these reservoirs, with their permanent pools and their effects on stream flow, will add greatly to water recreational facilities of the region, they will still fall far short of fulfilling the needs of the area.

Proposed separately as a wildlife conservation and recreational project only is diversion of excess flows from Walnut Creek into the Cheyenne Bottoms, a natural depression north of and adjacent to the Arkansas River upstream from Hutchinson, Kansas.

Erosion and Silting

Erosion by water is prevalent throughout the entire Arkansas Valley, especially east of the High Plains. In its effect on the water-courses of the Valley, the most undesirable results have been destruction of productive bottom lands by deposits of sand and infertile silt; silting of stream channels, irrigation canals, reservoirs, waterworks intakes, and so forth; high turbidity of flows, which affects the quality of the water supply for domestic and industrial use and for recreation; bank cutting, which has resulted in the destruction of many thousands of acres of bottom lands; and the widening of rivers to such an extent as to render unfeasible irrigation by direct diversion.

Perhaps the most destructive single result of erosion on the streams of the Valley has been the devastation

of bottom lands of the western rivers by infertile deposits. The damage in these instances is complete and there is little that can be done to repair it. Control of floods and land treatment programs will retard further shifting of sand and silt deposits, and thus will prove beneficial in salvaging the remaining bottomland areas which have not been destroyed. The proposed Foss Reservoir will prevent destruction of bottom lands along the Washita River by arresting a sand movement now in progress in the upper reaches.

Provision for silt storage is an important consideration in multiple-purpose reservoir development, and it is apparent that at some sites silt retention may constitute the major benefit. For example, the primary purpose of a reservoir on the lower Purgatoire River would be to provide replacement storage for the capacity of the John Martin Reservoir which eventually will be lost through silting.

Bank caving and cutting occurs extensively on nearly all of the major streams of the Valley and has caused the destruction of much valuable land. Remedial measures are expensive and in general can only be justified for protection of urban areas, bridges, bridge approaches, and other similar highly valuable property. The program of reservoirs for flood protection will result in a very material reduction of bank cutting, most of which normally occurs during flood periods.

The extensive land treatment and other flood control measures contemplated for the Valley will reduce erosion and silting to a large extent, resulting in improvement of conditions now aggravated by these phenomena. Storage is included in all proposed reservoirs to provide for reduction of capacity by silting.

Land Drainage

Land drainage as an important problem is limited largely to the extensive developments in the wide alluvial bottoms of the lower Arkansas, Red, and White Rivers. The individual drainage districts have originated almost entirely through private endeavor, and there has been little attempt at coordinating their development. The result is a hodgepodge of organizations, the majority of which are continually in financial difficulties, with administration inefficient, drainage structures inadequate, maintenance and repairs neglected, and the operation of certain districts adversely affecting adjacent ones.

Not only have many drainage districts themselves encountered serious difficulties, but their operation has often led to undesirable conditions with respect to land development, settlement, sale, ownership, and use, and also with respect to the finances of other units of local government. Important public interests, as well as the private interests of land owners and occupiers and district creditors, are involved in the problem of adjustments of drainage districts.

The inadequacy of existing drainage systems, and the financial difficulties which many of the present districts have experienced, have directed attention to the need for simplification, unification, and amendment of drainage laws and rectifications in organization and administrative practices to correct abuses, to reduce administrative expense, to facilitate economical and adequate financing, and to increase the efficiency of construction and maintenance for both old and new drainage improvements.

Little of specific value can be accomplished until a detailed study of present conditions is made. Such an investigation should determine the feasibility of modifying, reconstructing, rehabilitating, and coordinating established drainage systems and of developing new ones for proper land use. This investigation is strongly recommended as essential to the best development of the Valley.

Basic Data and Investigations

Statements of the best plan of water development for each sub-basin in the Arkansas Valley, based on information then available, were prepared in 1936 under the sponsorship of the National Resources Planning Board. These statements emphasized the lack of basic data and of investigations necessary for determining a full, rounded plan of basin development.

Since 1936, great strides forward have been made both in the collection of essential basic data and in the investigation of water problems. Many of the investigations have been undertaken upon the request or encouragement of the Drainage Basin Committees. The minutes of these Committees set out rather clearly the additional investigations still needed.

Basic data are still inadequate to determine the solutions to many problems, and additional investigations are necessary before a truly comprehensive plan of water development can be formulated. The physical feasibility of additional irrigation in the Upper Red River basin is indeterminate until data are obtained concerning the volume and quality of stream flow. Additional data are needed also for most of the region in connection with the determination of pollution abatement measures necessary to maintain established standards of minimum stream flow. Basic data concerning underground water reserves are essential to the development of this resource for irrigation and other uses. Regional evaluation of benefits which would accrue to irrigation and flood control are needed to indicate the ultimate developments which would be justified. Small reservoirs should be investigated thoroughly to establish their place in a satisfactory program of water development. These examples illustrate the importance

of obtaining additional basic data and of conducting further investigations.

Indicated below are additional basic data and investigations essential to further determination of programs for the control and development of the water resources of the Arkansas Valley.

Basic Data

1. West of the 98th meridian, with the exception of the Arkansas River above Garden City, Kans., stream flow records are in general inadequate, both in number and periods of record, to determine closely the availability of surface water supplies for irrigation and other purposes. The general network of rainfall and stream-gauging stations in the entire Valley should be supplemented to fill in gaps which now exist. Additional stream flow measurement stations are needed especially on streams draining areas between 10 and 100 square miles. In the Red and Washita River basins data are lacking to indicate water quality and suitability for irrigation.

2. Many more data are needed throughout the entire Valley concerning pollution of streams during critical periods to determine degree of treatment necessary to maintain satisfactory standards. In connection with this, additional information is needed also on low stream flows and on water quality with respect to mineral content.

3. Information on silt loads is needed throughout the area to provide information to guide the calculations for reductions in reservoir capacity by silting.

4. Data concerning ground-water reserves, rate of recharge, and safe withdrawal rates are necessary for intelligent expansion of ground-water irrigation in the western area, and elsewhere for municipal, industrial, domestic, and other uses.

5. Adequate maps are needed for much of the entire Valley.

Investigations

1. Regional evaluation of flood-control benefits to determine extent of justifiable flood-control program.

2. Regional evaluation of irrigation benefits to determine extent of justifiable irrigation program.

3. Thorough study of small reservoirs on small drainage basins and their relation to watershed development. Some yardstick should be developed to indicate the importance of recreational aspects and the portion of justification they can support. Special consideration should be given to innovation in design, particularly as it concerns spillway requirements.

4. Investigations for flood control and other purposes in watersheds which have not recently been studied.

5. An investigation to determine the need for and means of coordinating, rehabilitating, and refinancing of present organized drainage districts in the eastern part of the Valley, and the feasibility of developing new lands for cultivation through provisions for drainage.

6. A review of flood control capacities indicated for proposed reservoirs, comparing benefits accruing to various degrees of control with a view to selecting the optimum capacities.

7. Study of the Wichita Falls irrigation project from its inception to determine factors affecting the success of large-scale irrigation in the Upper Red River watershed.

8. A study of pollution conditions throughout the entire Valley to develop in detail a coordinated program for pollution abatement as heretofore outlined.

9. A survey of water supply requirements for the entire Valley, and investigation of measures to relieve present shortages and to improve unsatisfactory conditions.

10. Completion of surveys under way, or suspended for the duration of the war, to determine additional measures for flood control, irrigation, hydropower, navigation, and other water uses.

11. Studies directed toward development of a comprehensive plan for the coordinated regional operation of multiple-purpose reservoirs including flood control, irrigation, water supply, power production, interconnection of generating plants, and so forth.

TABLE 19.—*Water projects included in Arkansas Valley plan*

RESERVOIRS

[In selecting the projects listed herein for development of the water resources of the Arkansas Valley, consideration was given only to their physical and over-all economic feasibility as parts of a long-range comprehensive plan. Consideration was not given to such factors as who should build, operate, maintain or finance the proposed projects or programs. It was recognized that changes in the recommendations may be desirable as the work of accomplishing the plan proceeds. These projects, therefore, represent a tentative framework for development of the water resources, and should be considered as preliminary and suggestive rather than as constituting an adopted series of projects]

Project list No.[1]	Name	Watershed	Stream	Purpose[2]	Classification[3]	Remarks
1	Judsonia	White	Little Red	FP	4	Under investigation.
2	Greers Ferry	do	do	FP	2	Authorized.
3	Bell Foley	do	Strawberry	F	2	Do.
4	Water Valley	do	Eleven Point	FP	2	Do.
5	Fairdealing	do	Little Black	F	4	Under investigation.
6	Harviell	do	Cane Creek	F	4	Do.
7	Lone Rock	do	Buffalo	FP	2	Authorized.
8	Gilbert	do	do	FP	2	Under investigation.
9	Cotter	do	White	P	2	Do.
10	Bull Shoals	do	do	FP	2	Authorized.
11	Table Rock	do	do	FP	2	Do.
12	Galena	do	James	P	4	Under investigation.
13	Beaver	do	White	P	4	Do.
14	Nimrod	Arkansas	Fourche LaFave	FP	1	Completed as flood control project.
15	Wister	do	Poteau	F	2	Authorized.
16	Okmulgee	Arkansas (Canadian)	Deep Fork	P	4	Restudy proposed.
17	Canton	do	North Canadian	FID	1	Under construction flood control project.
18	Ft. Supply	do	Wolf Creek	FI	1	Completed as flood control project.
19	Beaver (Optima)	do	North Canadian	FI	2	Authorized.
20	Palo Duro	do	Palo Duro	I	4	
21	LaCueva	do	Mora	I	2	
22	Sapello	do	Sapello	I	4	
23	Tenkiller Ferry	Arkansas	Illinois	FP	2	Do.
24	Fort Gibson	do	Grand (Neosho)	FP	2	Do.
25	Markham Ferry	do	do	FP	2	Do.
26	Pensacola	Arkansas	Grand (Neosho)	FP	1	Completed, additional flood control storage needed.
27	Typical reservoir "A"		do	FWD	3	
28	Council Grove		do	FWD	2	
29	Marion	Arkansas (Neosho)	Cottonwood	FWD	2	
30	Oologah	Arkansas	Verdigris	FP	2	Authorized.
31	Typical reservoir "A"	do	Lower Verdigris Tributary	F	3	
32	Hulah	Arkansas (Verdigris)	Caney	FD	2	Do.
33	Elk City (Table Mound)	do	Elk	FWD	2	Do.
34	Fall River	do	Fall	FWD	2	Do.
35	Neodesha	Arkansas	Verdigris	F	2	Do.
36	Toronto	do	do	FWD	2	Do.
37	Mannford	do	Cimarron	FWD	2	Do.
38	Kenton	do	do	IF	4	Under investigation.
39	Typical reservoirs "A"	Arkansas (Salt Fork)	Chickaskia	F	3	
40	do	Arkansas	Walnut	FWD	3	
41	do	do	Slate	F	3	
42	do	do	Ninneseah	F	3	
43	Cheyenne Bottoms	do		C	2	Entails diversion from Walnut Creek.
44	Bear Creek	do	Bear Creek	I	2	Includes diversion from Arkansa River.
45	Apishapa	do	Apishapa	I	2	
46	Narrows	Red (Ouachita)	Little Missouri	FP	2	Authorized.
47	Blakely Mountain	Red	Ouachita	FP	2	Do.
48	Durden Ferry	do	Bayou Bodeau	F	2	Do.
49	Black Bayou	do	Black Bayou	F	2	Do.
50	Broken Bow	Red (Little River)	Mountain Fork	PF	2	
51	Narrows	Red	do	FP	2	
52	Alikchi	do	Little	FP	2	
53	Antlers	do	Kiamichi	FP	2	
54	McGee	do	Muddy Boggy Creek	F	2	
65	Tupelo	Red (Little Red)	Clear Boggy Creek	F	2	
59	Sandy Creek	Red	Blue	F	2	
57	Foss	do	Washita	FI	2	Res. essential to control sand movement.
58	Typical reservoir "A"	do	Washita and Tributaries	FIWD	3	
59	Little (East) Beaver	do	L. East Beaver	FI	4	
60	West Beaver	do	West Beaver	FI	4	
61	Mountain Park	Red (North Fork)	Otter Creek	IF	4	
62	Navajo	Red	North Fork	IF	4	
63	Sentinel	Red (North Fork)	Elk Creek	IF	4	
64	Mangum	Red	Salt Fork	IF	4	
65	Cap Rock	do	Prairie Dog Town Fork	I	4	

[1] Reservoirs existing or under construction for which no changes are proposed are not listed.

[2] Proposed purpose is independent of existing authorizations. F, flood control; I, irrigation; P, power; W, water supply; D, dilution of sewage; C, wildlife conservation. All reservoirs have provision for recreation and conservation pool.

[3] Classification:
(1) *Projects existing or under construction.*—Ultimate modification of present purpose proposed.
(2) *Projects proposed including authorized projects.*
(3) *Proposed reservoir (typical) projects.*—Investigations will determine number and location.
(4) *Desirable projects.*—Additional investigations needed to explore feasibility.
Investigations required in connection with reservoirs in classifications 3 and 4 are proposed.

TABLE 19.— *Water projects included in Arkansas Valley plan*—Continued

LEVEES

Map and project list No.	Name	Watershed	Stream	Farm land protected acres	Classification [3]	Remarks
66	Augusta to Laconia circle	White	White		2	Authorized. Lower section under construction.
67	Pevalls Bluff	do	do	Urban	2	Authorized.
68	Big Bottom	do	do	9,600	2	Do.
69	Success	do	Little Black	36,000	2	Do.
70	Poplar Bluff, East Poplar Bluff	do	Black	Urban	2	Do.
71	Poplar Bluff to Arkansas-Missouri state line.	do	do		2	Do.
72	Pig Creek	do	Big Creek	60,000	2	Levee to withhold L'Anguille River flows.
73	Foster Ledge to Olyphant	do	White	29,100	4	Under investigation.
74	Jacksonport	do	do	2,800	4	Do.
75	Curia Creek to Otter Lake	do	Black	14,100	4	Do.
76	Little Red River levee districts Nos. 1 and 2.	do	Little Red		4	Do.
77	Little Rock to Pine Bluff (South Bank)	Arkansas	Arkansas	25,100	2	Authorized.
78	Little Rock	do	do	Urban	2	Do.
79	Conway levee districts 1, 2, 8	do	do	15,900	2	
80	West of Morrilton	do	do	44,000	2	Includes cut-off and channel clearing for Point Remove Creek. Part Authorized.
81	Carden Bottoms (Petit Jean River)	do	do	7,500	2	
82	Near Dardanelle	do	do	6,900	2	Authorized.
83	Clarksville on Spadra Creek	do	do	Urban	2	Do.
84	McLean Bottom (Six Mile Creek)	do	do	10,500	2	
85	Crawford County levee district	do	do	15,200	2	Do.
86	Oklahoma City, Okla	do	North Canadian	Urban	2	
87	Fort Gibson Bottom	do	Arkansas	2,400	2	Do.
88	Caney Creek	do	Caney Creek	2,400	2	Do.
89	West of Elk City	do	Elk River	1,900	2	Do.
90	Tulsa and West Tulsa	do	Arkansas	Urban	2	Do.
91	Blackwell	Arkansas	Chickaskia	Urban	2	Authorized
92	Vicinity of Cherokee	do	Salt Fork	do	2	Authorized. Includes floodway.
93	Kaw	do	Arkansas	do	2	Authorized
95	Big Slough to Belle Plain	do	do	11,500	2	Authorized. Includes floodway.
96	Wichita and Valley Center	do	do	Urban and farm	2	Do.
97	Hutchison (Cow Creek)	do	Cow Creek	Urban	2	Authorized. Includes diversion floodway.
98	Calion	Red	Onachita	do	2	Authorized
99	Grant Parish below Colfax, La	do	Red	Urban and 41,000.	2	Authorized. Project includes channel improvements to Bayous Darrow and Rigolette.
100	Hot Wells to Alexandria, La	do	do	Urban and 50,000.		
101	Loggy Bayou to Coushatta Bayou	do	do	8,000	2	
102	Poston Bayou	do	do	16,500	2	Levee enlargement and channel improvement.
103	Manice Bayon	do	do	9,700	2	Levee extension across Manice Bayou.
104	Jefferson City, Texas	do	Cypress Cr	Urban	2	
105	Pauls Valley, Okla	do	Washita	do	2	

PROPOSED CHANNEL IMPROVEMENTS

Map and project list No.	Name	Watershed	Stream	Classification [3]	Miles of improvement	Remarks
106	Colorado Springs, Colo	Arkansas	Shooks Run-Templeton Gap	2		Floodway through city.
107	Big Creek (Colewa Creek)	Red (Ouachita)	Big Creek	2	85	Includes levees and diversion canal.
108	Bayou Bartholomew	do	Bayou Bartholomew	2	313	Includes channel improvement of Deep Bayou.
109	Little Missouri River below Murfreesboro, Ark.	do	LittleMissouri	2	93	Authorized.
110	Ozan Creek	do	Ozan Creek	2	12	Do.
111	Terre Noire Creek	do	Terre Noire Creek	2	16	Includes repair of levees.
112	Bayou Bodcau	do	Bayou Bodcau	2	45	Authorized. Includes channel improvement of Red, Chute, and Loggy Bayous.
113	Sulphur River	Red	Sulphur River	2	389	Includes major tributaries.
114	Kelly Bayou Diversion	do	Kelly Bayou	2	2½	Diversion canal to Red River.
115	McKinney Bayou	do	McKinney Bayou	2	37	Construction and extension of existing floodway.
116	Walnut Bayou	do	Walnut Bayou	2	21	
117	Chickasha	do	Washita	2		Floodway for Line Creek.

NAVIGATION

Project list No.	Stream	Present navigation		Feasible navigation 9-foot channel		Remarks
		Type	Miles	Head	Miles	
118	Arkansas & Verdigris	Intermittent	111	Tulsa, Okla	523	These projects are not definite proposals but indicate waterways that are feasible of development for 9-foot navigation.
119	Red	do	310	Shreveport, La.	310	
120	Ouachita	Dependable 6-foot	351	Felsenthal, Ark	242	

Note 3 on p. 65.

TRANSMOUNTAIN DIVISION—COLORADO RIVER TO ARKANSAS RIVER [4]

Map and project list number	Project	Colorado River tributary	Arkansas River tributary	Amount of diversion, acre-feet	Remarks
121	Frying Pan	Frying Pan River	Lake Fork River	40,000–70,000	
122	Gunnison	Gunnison River	South Fork River	250,000–280,000	
123	Sugar Loaf Reservoir		Lake Fork River		Increase capacity of existing reservoir to regulate water diverted from Frying Pan River.
124	Pueblo-Las Animas pipe line				For distribution of transmountain water for municipal use.

IRRIGATION—SURFACE SUPPLIES INCLUDING ALLUVIUM [5]

Map and project list number	Basin	Stream	Source of supply	Reservoir project list number	Proposed acreage	Classification [3]	Remarks
125	Arkansas	Apishapa	Apishapa Reservoir	45		2	Supplemental supply.
126	do	Bear Creek	Bear Creek Reservoir	44		2	Diversion from Arkansas River. Supplemental supply for land in vicinity Garden City, Kans.
127	do	Arkansas River	Arkansas River		14,600	2	Scattered tracts supplied by pumping from the alluvium.
128	do	Pawnee River	Pawnee River		12,000	2	Scattered tracts supplied by pumping from the stream and alluvium.
129	do	Cimarron River	Kenton Reservoir	38	15,000	4	
130	Arkansas (North Canadian).	Palo Duro Creek	Palo Duro Reservoir	20	3,200	4	
131	Arkansas	North Canadian River	Beaver Reservoir	19	6,000	2	
132	do	North Canadian	Fort Supply Reservoir	18	3,500	2	Proposed reallocation. 8,000 acre-feet storage.
133	Arkansas	North Canadian River	Canton Reservoir	17	18,000	2	Proposed reallocation. 50,000 acre-feet storage.
134	Arkansas (South Canadian).	Sapello River	Sapello Reservoir	22		4	Supplemental supply for 4,000 to 5,000 acres irrigated at present.
135	do	Moro River	LaQueva Reservoir	21		2	Supplemental supply for 6,500 acres irrigated at present.
136	Red River	Prairie Dog Town Fork	Cap Rock Reservoir	65	4,500	4	
137	do	Salt Fork	Hollis Reservoir	64		4	Supplemental supply for Lugert Altus project.
138	do	North Fork	Navajo Reservoir	62	28,500	4	
	do	Elk Creek	Sentinel Reservoir	63			
	do	Otter Creek	Mt. Park Reservoir	61			
139	do	Wichita River	Lake Kemp		52,000	4	Expansion of present project area.
140	do	Washita River	Foss Reservoir	57	25,000	2	
141	do	Beaver Creek	West Beaver Reservoir	60		4	
			East Beaver Reservoir	59	7,800		
	Total				[6] 190,100		

[3] Note 3 on p. 65.
[4] See Fig. 7.
[5] See Fig. 8. Programs for land treatment and runoff retardation are discussed and outlined in the *Land* section.
[6] Additional irrigation by direct diversion utilizing return flows from irrigation possible downstream from proposed projects.

MINERALS

The Arkansas Valley is one of the richest mineral areas in the entire Nation, with great quantities of petroleum, gas, lead, zinc, bauxite, coal, salt, iron, helium, lime, clay, and precious metals.

Unfortunately, however, extraction and use have not always been wise. In some cases local supplies have been completely exhausted. In others, the cream of the resource has been skimmed and the rest left in such a state that extraction now is extremely difficult and uneconomical. In still other cases, the use of resources has been reckless. Power and energy contained in vast quantities of natural gas uselessly released during the operation of artesian oil wells have gone unharnessed and unutilized. In the Texas Panhandle alone, in 1934, the waste of gas reached a peak of more than 1 billion cubic feet per day, enough for all the domestic consumers in the Nation for a year, or those of Texas for 17 years. Although greatly reduced since that time, waste still remains high, especially in gas treated for removal of natural gasoline.

On the whole, methods of extraction have been extremely inefficient and uneconomical. It has been estimated, for example, that between 1921 and 1937, a period of discovery and development, only 20 percent of the oil in reservoirs was recovered, due to lack of knowledge of efficient extraction methods. Scientific production processes developed in the past decade and applied in both old and newly discovered pools, have resulted in recovery of more than 50 percent of the oil.

It is necessary to draw up very thorough and comprehensive provisions calling for the wise use and conservation of these precious but exhaustible mineral resources. They must be utilized fully, completely, and with minimum waste, through a proper weighing of

technical and economic considerations. The inferior portions of the deposit must be worked in balance with the superior portions. It is unwise to take the best and leave the remainder completely valueless.

Finally, it must be remembered that the public, too, has a stake in mineral resources, and not the individual owner alone. The public must insist that the owner use raw materials wisely, and in accordance with public as well as individual welfare. The Southwest has been dangerously slow to recognize this need. With the economy of the region so dependent upon the extraction of raw materials, group interests must come before individual interests.

Mineral Resources of the Valley

The Arkansas Valley may be divided into two mineral areas. The first and by far the most important area extends west from those portions of Missouri, Arkansas, and Louisiana included in the Valley to the western boundaries of Oklahoma, Texas, and Kansas.

This area has most of the petroleum, natural gas, and helium, and all the known iron, bauxite, salt, and sulphur in the Valley. It also has great quantities of coal, lead, zinc, limestone, building materials, ceramic clays, glass sands, and barite, and lesser quantities of manganese, mercury, antimony, and diamonds.

The second main mineral area includes the southeastern corner of Colorado from Leadville to the Kansas border, and extends into the northeast corner of New Mexico. This region has much gold, silver, molybdenum, lead, zinc, coal, and ceramic clays, and smaller amounts of copper, flourspar, antimony, barite, beryllium, feldspar, manganese, tungsten, vanadium, vermiculite, helium, carbon dioxide gas, and lesser minerals.

The following minerals exist in commercial quantities:

Antimony
Ash, volcanic
Barite
Bauxite
Bentonite
Beryllium
Caliche
Carbon-dioxide gas
Clay (ceramic)
Coal
Copper
Diamonds
Feldspar
Fluorspar
Gas
Petroleum
Glass sand
Gold
Gypsum
Helium gas
Iron ore
Lead
Lignite
Limestone and dolomite
Manganese
Marble and crystalline limestone
Mercury (cinnabar)
Molybdenum
Natural gas
Novaculite
Tungsten
Phosphate rock
Salt
Silver
Vanadium
Vermiculite
Zinc

Petroleum and Natural Gas

Petroleum is by far the most important single mineral resource in the Arkansas Valley. It is found in East Texas, North Central Texas, and the Panhandle, and in Louisiana, Oklahoma, Arkansas, and Kansas. Production for 1941 was over 350 million barrels. Proved reserves are in excess of 3½ billion barrels and, at the current rate of production, will last about 10 years.

Among the various parts of the Valley, however, there is considerable variation in the ratio of present production to reserves. In Oklahoma and Kansas proven reserves would last only about 7 years at the 1942 rate of production. In Arkansas the life of known reserves will be approximately 11 years, and in Louisiana, more than 12. In Texas, most of which is outside of the Arkansas Valley, the proven reserves as of the end of 1942 were 24 times the 1942 production. Discoveries of new pools have been relatively more favorable in Louisiana, Arkansas, and even in northern Texas; and the extension of existing pools has been especially important in Kansas. In Oklahoma, however, new discoveries are running behind production.

In many parts of the area, particularly in Oklahoma, there are numerous communities which have lost in population and in economic importance because of the drop in oil production. The economic future of many of these places could be enhanced by the adoption of cooperative means of recovering portions of the remaining petroleum reserves. The lives of many pools could be extended a number of years and large quantities of otherwise lost resources could be recovered by the injection of water or gas at certain places in these pools. These measures would usually require joint operations among lease holders.

The principal natural-gas producing areas, exclusive of gas produced in the oil fields, are in the Texas and Oklahoma Panhandle, southwestern Kansas, southern Arkansas, and northern Louisiana. The total proven reserves are over 25 trillion cubic feet. There is the further possibility that the southwest Kansas gas field may add another 20 trillion cubic feet to present known reserves. Proven reserves are sufficient to last well over 25 years.

In commercial importance natural gas is second to petroleum in the Arkansas Valley. Inefficient petroleum production has resulted in the waste of vast quantities of gas by release into the air. Large amounts are converted into carbon black through very

FIGURE 10.

(Face p. 68)

uneconomical methods; these operations are carried on mainly in the Texas Panhandle.

Natural gas and petroleum are two very important fuel resources which can be used directly for heat or indirectly for power production. Before using natural gas as a fuel, valuable materials can be extracted without reducing the efficiency of the gas for this purpose. Products that can be produced from natural gas include carbon black and similar products, gasoline, and others. It is the belief of many scientists that natural gas will prove ultimately to be a more dynamic raw material than petroleum from the viewpoint of chemical industries.

Coal and Lignite

The Arkansas Valley contains 3 percent of the Nation's coal reserves. Of the four large coal areas located in the Valley, one lies in western Arkansas and eastern Oklahoma. Another includes southeastern Kansas and southwestern Missouri. A third comprises Las Animas and Huerfano counties in Colorado and Colfax County in New Mexico. The fourth includes El Paso and Fremont Counties, Colorado, and runs northward out of the Arkansas Valley.

The Arkansas coals vary from medium-volatile to semi-anthracite, and, being low in volatile matter, are noncoking. Coke can be produced, however, if pitch or coking bituminous coal is added. Because of the amount of "slack" in this coal it can be converted into briquets which have one-third the value of lump coal. To do this it is necessary to add 6 to 10 percent of pitch.

The Oklahoma coals are coking coals and will be used in the iron blast furnace at Daingerfield, Tex.

The coal of the Trinidad-Raton area is a high-grade bituminous coking coal. This coal deposit is used extensively by the Colorado Fuel and Iron Company in its blast furnace at Pueblo.

The coal in El Paso and Fremont Counties, Colo., is a subbituminous coal.

Production of coal in Arkansas and Oklahoma in 1941 amounted to 3,423,000 short tons. The coal production of southeast Colorado in 1941 is estimated at more than 2,500,000 tons.

Coal reserves in Arkansas are estimated at 1,500,000,000 tons, or enough to last more than 800 years at current rates of extraction. Reserves in Oklahoma are estimated to be 55 billion tons, or enough for many thousands of years. The reserves of that part of Colorado which lies in the Arkansas Valley are likewise tremendous.

Enormous lignite deposits of a quality ranking below that of subbituminous coal, exist in Arkansas, Texas, and Louisiana.

The reserve in Ouachita County, Ark., alone is estimated at 75,000,000 tons. It is used chiefly in fuel briquets, but has byproducts of tar, wax, and soap materials.

Other Non-metallic Minerals

Helium gas.—The major world supply of helium, a noninflammable gas used in lighter-than-air craft, occurs in the Texas Panhandle. The largest deposit, and the only one that is now being operated, is near Amarillo, Texas. Others are known in New Mexico, Colorado, and Kansas. One new plant in the Texas Panhandle is almost completed and four others are authorized for construction. A new plant is also being constructed in Kansas. All plants are federally owned and are operated by the U. S. Bureau of Mines. Most of the known reserves are federally owned.

Carbon-dioxide gas.—Large deposits of carbon-dioxide gas are found in northeast New Mexico. These deposits are substantial enough to permit establishment of a dry-ice industry.

Limestone and dolomite.—The limestone and dolomite region of southern Missouri, northern Arkansas, northeastern Oklahoma, and southeastern Kansas covers thousands of square miles and contains unlimited reserves. Southern Oklahoma contains two large areas, one in the Arbuckle Mountains and one in the North Wichita Mountains.

Limestone-chalk deposits are scattered all over the Arkansas Valley.

Lime sold or used by producers in Missouri alone in 1941 amounted to 736,200 short tons valued at $4,106,468.

Ceramic clays.—Enormous quantities of ceramic clays are located within the Arkansas Valley. Large deposits are found in the north-central Ozark Mountains of Missouri, in southern Arkansas, around the Red River south of the Wichita Mountains in Texas and Oklahoma, in east Texas, and in northern Louisiana. Most of these clays may be used to manufacture numerous products such as brick, tile, and pipe. Arkansas has some fine pottery, refractory and china clays. Large clay deposits are also located in southeast Colorado. Production in the State of Missouri alone during 1939 totaled 384,655 tons.

Glass sand.—Extensive deposits of glass sands exist in northern Arkansas, northeast Oklahoma, and the southern border of the eastern half of Oklahoma adjacent to the Red River.

These are high-grade deposits, and the reserves are sufficient to permit development of a major glass industry.

Barite.—Fifty percent of all barite mined in the United States is extracted in Missouri. There are two

uneconomical methods; these operations are carried on mainly in the Texas Panhandle.

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barite areas in Missouri, one covering Washington, Franklin, Jefferson, and St. Francois Counties; the other including Moniteau, Cole, Camden, and Morgan Counties. Together they represent an area of 1,984 square miles.

Production in 1941 amounted to 212,718 short tons and was valued at $1,337,756. The reserves are very large and extraction is simple.

Barite is used for well drilling, paint, glass, rubber, chemicals, floor covering, and for other purposes.

Phosphate.—Excellent phosphates are found in Independence, Izard, and Stone Counties in northern Arkansas. Phosphates of a lower grade exist in Oklahoma.

Reserves in Arkansas are estimated to be from 10,000,000 to 20,000,000 tons.

This phosphate, combined with the sulphur obtained from sour-gas purifying plants in southern Arkansas, provides enough sulphuric acid to create a superphosphate industry which could sell low-cost fertilizers to the farmers of the Arkansas Valley.

Salt.—Salt beds occur in southwestern and central Kansas and western Oklahoma, extending into Colorado and New Mexico. There is also a large salt area in northern Louisiana.

The production in the State of Kansas alone in 1941 was 781,014 tons, valued at over $3,000,000. Its reserves of salt are estimated at 5,000 billion tons.

Gypsum.—Huge gypsum deposits extend across western Oklahoma, running north into Kansas and southwest into the Texas Panhandle. A large high-grade commercial deposit is found in Hempstead County, Arkansas. Smaller amounts are found in Colorado.

Production in Oklahoma in 1941 was 258,258 short tons, valued at $344,489. Production for 1941 in Coloradio is not available, but for 1940 it was 24,641 short tons, valued at $36,787.

Cement.—Arkansas Valley States are large producers of cement. Plants within the Valley account for about 6 percent of the national Portland cement manufacturing capacity. Kansas plants, all but one in the southeast corner of the State, shipped nearly five million barrels in 1941, more than half of which went outside the State.

Volcanic ash.—Local deposits of volcanic ash, with large reserves, are widely scattered throughout Kansas, Oklahoma, the Texas Panhandle, and Louisiana. In 1940, Kansas produced 39,215 tons of ash, which represented 47 percent of total domestic production and was valued at $129,959.

Volcanic ash is used as an abrasive, in polishing and cleaning compounds; other uses include toothpaste and powders, mechanic's soap, sweeping compound, erasers, and for other purposes.

Bentonite.—Bentonite, an alteration product of volcanic ash, is found in Kansas, Oklahoma, Colorado, Texas, and Louisiana.

Bentonite is used in filtering oils, in moulding sands, in construction of dams, plaster, cements, and in other ways.

Marble.—Marble or crystalline limestone are found in northern Arkansas and in Missouri. Production in Missouri in 1940 amounted to 14,180 tons, valued at $375,209. Production in Arkansas for the same year amounted to 1,830 tons, valued at $29,854.

Granite.—Large deposits of granite occur in the Ozark area of Missouri, and in the Arbuckle and Wichita Mountain regions of Oklahoma. These granites are high in feldspar content.

Production in Oklahoma in 1940 amounted to 3,250 short tons, valued at $177,085. Production in Missouri amounted to 2,630 tons for the same year.

Metals

Bauxite.—This mineral, from which aluminum is made, is found in Pulaski and Saline Counties, Ark. In 1941, more than 800,000 long tons of bauxite were shipped from Arkansas to be processed in other centers. This constituted over 90 percent of the total domestic production. The reserves of high-grade bauxite are estimated at around 18,000,000 long tons in alumina content, but if it becomes necessary to meet with domestic resources the accelerated needs occasioned by the war these resources will be exhausted in less than 4 years. During the war period, plants to refine bauxite and to reduce the pure alumina to aluminum have been located in Arkansas. These will process medium, as well as high-grade bauxite.

Small quantities of bauxite exist in southeast Colorado.

Zinc.—The largest and best deposits of zinc are found in the Tri-State Lead and Zinc District which embraces southwest Missouri, southeast Kansas, and northeast Oklahoma. Large supplies of low-grade zinc are found in south-central Missouri and north-central Arkansas. These are being used to an increasing degree during the war period under the stimulus of a special price bonus.

The production of the Tri-State District in 1940 totaled 232,670 short tons, which constituted 35 percent of domestic production of zinc and 14.2 percent of world production. Output in 1931 rose to 258,837 tons. Oklahoma continued to be the leading producer in the country by a wide margin.

Known reserves of high-grade zinc are rapidly being

depleted. Additional producing areas, however, are likely to be found within the Tri-State District. There is the possibility that this District will expand to the Northwest and West, and that ore will be found at greater depths.

Colorado has considerable amounts of zinc in Lake Chaffee, and Custer Counties. Since 1859, over $97,880,000 worth of zinc has been extracted in these counties. In terms of value, zinc ranks fourth among the mineral of south-central Colorado.

Lead.—The southeastern Missouri lead region, which is largely in St. Francois and Madison Counties, is by far the most prolific lead producing region in the Nation. In 1939, a total of 169,893 short tons of lead was produced, which was 38 percent of the Nation's production. Output dropped to 164,342 tons in 1941. The ores of this area contain about 74.6 percent pure lead; reserves are very extensive.

There are also large lead reserves in the Tri-State District, which includes southwest Missouri, southeast Kansas, and northeast Oklahoma. Output in this district in 1941 amounted to 41,080 short tons, roughly five-eighths in Oklahoma and three-eighths in Kansas. Lesser amounts of lower-quality lead are found in south-central Missouri and north-central Arkansas.

Considerable amounts of lead are mined in Lake, Chaffee, Fremont, and Custer Counties in Colorado, and smaller quantities in San Miguel County, N. Mex. Production of lead since 1859 in Colorado totals over $100,493,000, and is the third-ranking mineral in terms of production value.

Iron.—An important iron ore deposit is found in Iron, Madison, and St. Francois Counties in southeastern Missouri. Another large deposit is located in east Texas around Marion County, extending south-westward for a considerable distance. Both of these deposits are in commercial production.

A third but much less important area is that of the Brown and Red Iron Ore districts of southeastern Missouri and the Arkansas Ozarks. This area contains some 8,700 square miles of reserve supplies, but the iron ore exists in scattered deposits. However, two mines in Crawford County have produced 1,000,000 tons. The main problem in this region is one of determination of location, quantity, and quality of the ore.

The iron reserves of the Arkansas Valley are large, sufficiently so to sustain several moderate-sized steel mills for a long period of time.

Molybdenum.—The production of molybdenum occurs in the Leadville region of Colorado. Output in 1938 totaled 28,242,085 pounds and, in 1939, 21,796,110 pounds. The latter quantity represented 72 percent of the domestic production of molybdenum, and 66 percent of the world production. In 1941, output was almost back to the 1938 level.

The cumulative value of metal produced by the end of 1939 was $93,653,000. Reserves are in excess of 200 billion pounds.

Gold.—Large quantities of gold have been mined in southeastern Colorado, and considerable amounts still remain. Production of gold since 1859 is valued at over $452,770,000. The principal production occurs in Lake, Chaffee, Fremont, and Custer Counties.

Silver.—A total of $202,583,000 worth of silver has been extracted in south central Colorado since 1859. Considerable silver is still being mined in Lake, Chaffee, Park, Teller, Fremont, and Custer Counties. The value of silver produced in southeast Colorado is second to that of the gold produced there.

Copper.—A small amount of copper is being mined in south-central Colorado. Value of copper produced there during the last 80 years amounts to $16,551,000.

Manganese.—Ferro-grade manganese occurs in Independence, Stone, and Izard Counties in northern Arkansas. Deposits of low-grade ore are to be found in west-central Arkansas. Deposits of minor commercial importance exist at present in Oklahoma.

Production of manganese in Arkansas is 22.2 percent of the high-grade metallurgical manganese produced in the Nation. In 1940, this State produced 7,077 long tons of manganese, valued at $192,000.

The reserves of Arkansas are estimated at 322,000 long tons of high-grade ores with a content of 35 percent of metallic manganese, and 322,000 long tons of low-grade ore containing 10 to 35 percent of metallic manganese. Reserves of low-grade ore in western Arkansas are very large.

Mercury (Cinnabar).—Mercury is found in Howard, Clark, and Pike Counties in west-central Arkansas. Production in 1940 consisted of 1,159 flasks of 76 pounds each, valued at $204,992. Output nearly doubled in 1941.

The reserves are exhaustible within a few years if intensive development is followed.

Proper Utilization of Minerals in the Valley

Provision must be made for the wise use and conservation of exhaustible mineral resources, particularly oil and natural gas.

The cream of the resources should not be skimmed off in such a manner as to increase the difficulty in extracting the remainder. There must be elimination of wasteful methods of extraction which may, for example, cause a flowing oil well to run dry prematurely, or which may permit valuable natural gas to be lost in the process of obtaining petroleum.

Provision must be made for the orderly development and utilization of the mineral resources in the Valley so as to extend the useful life of the deposits over as long a period as possible.

Finally, provision must be made to stabilize the employment of miners and others who are at present employed only spasmodically.

The following provisions are essential in drawing up a sound, comprehensive program for the utilization of minerals.

1. *Federal-State conservation compacts.*—In view of the exhaustibility of their mineral resources, the various States of the basin should, with the consent and cooperation of the Federal Government, enter into compacts for achieving mineral conservation. These compacts should include provisions for encouragement of an economic organization in the mineral field that will reduce losses from excessive competition and resource waste; agreement on tax and public land policies to effect conservation; and uniform use of the police powers of the State to prevent waste.

2. *Conservation commissions.*—The authority of the conservation commissions in the Valley should be greatly enlarged and should include broad powers to prescribe and enforce regulatory measures controlling wasteful mining practices. In those industries burdened with surplus capacity and low prices, these commissions should be empowered to permit, under public supervision and with due regard for the rights of the consumer, collective action among producers to control production in order to attain economic stability and prevent serious waste of resources.

Moreover the conservation commission, in collaboration with other State and Federal agencies, would:

a. Prepare geological, topographical, and aerial maps of the Valley.

b. Explore, locate, appraise, evaluate, and list the quantity and quality of the mineral resources of the region.

c. Study the possibility of more efficient and economical methods of extraction of minerals, particularly low-grade deposits and complex ores. Full consideration should be given to mechanization of mining, safety devices, and other factors.

d. Study the possibility of more and better industrial uses for mineral raw materials. Consideration should be given to the possibility of making new products from minerals, of combining minerals in new and more effective ways, of overcoming technical production difficulties, and of finding industrial uses for the low-grade resources such as lignite, and the partially used resources such as natural gas, coal, and clays.

e. Make consumption studies and forecast need for minerals.

f. Curtail further gas wastage by intensive repressuring and storage in the ground, or by more effective utilization.

g. Prevent stream pollution by proper handling of mine wastes and brines.

h. Require that strip mining areas be leveled off and perhaps afforested.

i. Classify certain uses of natural gas as wasteful and prohibit them.

3. *Changes in State laws.*—State laws should be revised in such a way as definitely to recognize the public interest in the mineral resources of the State, and to prevent private owners from exploiting them without regard for the public welfare. In addition, it will be necessary for the States to:

a. Adopt measures in cooperation with the Federal Government to rehabilitate chronically unemployed mine workers and stranded mining communities. In the Arkansas Valley this would include the tiff mining area of Missouri, and the bituminous coal area of Arkansas, Oklahoma, Colorado, and New Mexico. Unit operation and mechanization may be the solution for the former. A development of nylon and other chemical industries, and of steam generation of electricity, would aid in the solution of the latter.

b. Encourage for the duration of the war the development of minerals previously imported, and of minerals important to national defense, by loaning funds at low interest rates, by making available low-cost power, and transportation, by providing for discovery and depletion allowances in income taxation, and other devices. The Federal Government, by grant of subsidy, could encourage the development of low-grade ores of critical minerals. In addition, Federal research should be applied to the technical and economic problems of processing low-grade ores so as to develop new processes which will be competitive with other processes and higher grade ores in the post-war period.

c. Expend public funds to acquire mineral deposits which not only would help to stabilize the price and output problem of mining but would also furnish a reserve stock of exhaustible minerals. Mineral lands obtained by the State through tax delinquency should be held in reserve until needed.

d. Consider assessment of variable ad valorem taxes for certain types of mineral lands to insure full use of the resources. Very nominal ad valorem taxes might

be levied on reserves up to a reasonable ratio to production, but very large taxes on excess reserves. Thus, while it would be made decidedly unprofitable to keep large holdings of idle reserves, necessary production would not be deterred.

e. Impose an added severance tax upon the extraction of minerals, and use the income thus acquired for research on the industrial utilization of these minerals and for actually promoting these industries. This would be justified by the fact that the public has an interest in these exhaustible resources and ought to receive a commensurate return for them.

4. *Freight rate revisions.*—At present, the interterritorial freight rates are extremely favorable on raw materials but extremely unfavorable upon finished commodities. Both of these act against the interest of a developing region by causing it to export exhaustible resources in unprocessed form, thereby losing the valuable industry, employment, and income that accompany fabrication. If freight rates on raw minerals were made relatively commensurate with rates on finished goods, the fabrication and processing of these raw materials within the region would be greatly encouraged.

5. *Education.*—A broad educational program must be initiated at both the public school and adult levels, which will stress the wise use and conservation of mineral resources, and will obtain from them the full amount of industrialization which is consistent with this mineral base.

6. *Leasing policies.*—Those leasing policies which relate to mineral resources on Federal and State lands should be harmonized, and future leasing should be administered to adjust production to market needs. Mineral rights on tax-reverted lands should be retained by the States.

POWER

From the long-range viewpoint, development of the power resources of the Arkansas Valley must go hand in hand with development of the natural resources in order to meet the many requirements of modern industry as well as the increasing domestic and commercial power requirements that will accompany industrial development. An adequate and low-cost power supply can, with the adoption of progressive rate policies, encourage development of the Valley's resources and improve the welfare of the people.

From the point of view of the near future, the primary power problem is the furnishing of an adequate supply for the many and varied war loads that are either already being served or must be served in the next two years.

The power supply of the Valley is now obtained largely from fuel-burning plants, and is insufficient for the needs of regional growth. Even if a large number of the economically feasible hydroelectric sites are developed, there will still not be a disproportionate amount of water power in the Valley's over-all power supply. Since the passage of the 1936 Flood Control Act and subsequent acts authorizing the construction of various multiple-purpose projects, hydroelectric power has been receiving far greater attention; continuing attention to this valuable resource of the area is of vital importance in its long-range development.

Existing and Potential Power Developments

A statement of the existing developments within the exact area under study would be relatively meaningless because of the trend toward regional interconnection and coordination of the existing and potential power resources. Of more significance is a summary of power development in the various States which are wholly or partly included within the Valley boundaries.

Almost 87 percent of the total installed generating capacity in these States as of December 31, 1941, was in fuel-burning plants (see table 20). The output of these plants was slightly over 87 percent of the total generation in 1941. If the hydroelectric developments in northern and western Colorado and those in Missouri that are supplying power to load centers not truly tributary to the Valley are excluded from the total, the predominance of fuel plants and the energy supply from such plants is even more apparent.

Table 20 also illustrates the predominance of natural gas as a primary source of electric energy, inasmuch as it accounted for about 76 percent of the kw.-hr. generated for public use in these eight States in 1941. The trend today is toward even greater use of natural gas.

There is, however, an abundant supply of coal in the Valley from which power can be produced at costs quite comparable with costs at gas-fueled plants. In-

creasing opportunity should be created for the utilization of these coal resources for the production of power which will be required in tremendous amounts for the full development of this area. Some studies of a preliminary character have been made looking to the use of coal at mouth-of-mine steam-electric plants in Arkansas. Also plans have been drawn up for some of these plants, as well as for the construction of small reservoirs to impound water for gravity supply of condenser water. Any long-range plan of development is certain to include the use of coal in increasing amounts.

From the power standpoint the Valley is relatively self-sufficient in that most of its power supply is generated in plants located within its boundaries. Considering transfers between States of the Valley, of particular significance is the fact that Arkansas imported from other States 86 percent of its total energy requirements in 1941.

Federal Action

The Flood Control Act of 1938 and those of subsequent years authorized the Corps of Engineers, United States Army, to prosecute in this region and in many other sections of the country, a plan for control of floods, development of power, and other purposes. Selection of individual projects was left to the discretion of the Secretary of War and the Chief of Engineers, United States Army, working in cooperation with the Federal Power Commission. Recommendations on the installation of penstocks for the present or future development of power and determination of the proper power installation were placed jointly in the hands of the Federal Power Commission and the Chief or Army Engineers.

Under the provisions of this legislation, many multiple-purpose projects in which power and flood control, and in some cases other functions, will be combined, have been studied, selected, and where funds were appropriated, placed under construction. Considerable additional studies and investigations remain to be made.

The Federal Government has otherwise been active in assisting in the construction of multiple-purpose projects in this general region. The Possum Kingdom hydroelectric project on the Brazos River in Texas was constructed with the financial assistance of the Work Projects Administration. The Austin, Inks, Buchanan, and Marshall Ford projects on the Colorado River in Texas were all constructed with the financial assistance of the Federal Government, and the design and construction of the Marshall Ford Dam was under the supervision of the Bureau of Reclamation. More recently, the Federal Works Agency has taken over the operation of the Pensacola hydroelectric project on the Grand River in Oklahoma under authority of an Executive order of the President. This agency also has plans for the construction of the Markham Ferry and Fort Gibson projects on the Grand River below Pensacola.

Steam-Electric Projects

The steam-electric generating capacity in the Valley is now being materially increased, largely by expansion of existing utility system plants. However, several new plants are also under construction both by utility companies and by the Federal Government.

The actual completion of some of these projects, as well as the undertaking of additional projects, will depend upon their relative importance in the war program and their approval by the War Production Board. Fuel-burning plants, such as those being built for the aluminum plant at Lake Catherine, Ark., and for ordnance plants at several locations in the Valley, will no doubt be completed and, after the war, may be partly or wholly available for peacetime uses.

TABLE 20.—*Total installed capacity, generation, and interstate transfers of energy—1941*

State	Installed capacity—kw.-hrs.[1]		Generation—1,000 kw.-hr.[2]		Generation by type of fuel—1,000 kw.-hr.[3]				Movement of energy across State boundaries[2]—1,000 kw.-hr.		Energy available in State[2]—1,000 kw.-hr.
	Hydro	Fuel	Hydro	Fuel(6)	Coal	Oil	Gas	Total	Imports	Exports	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Arkansas	67,000	88,600	135,509	272,567	23,831	31,237	212,345	267,413	665,492	299,046	774,522
Colorado	66,100	276,600	245,567	572,149	546,429	31,314	32,352	610,095	48,648	3,374	862,990
Kansas	6,900	531,100	22,990	1,536,114	318,974	120,239	1,104,114	1,543,327	65,713	219,341	1,405,476
Louisiana	0	420,600	0	2,449,108	0	110,999	2,337,968	2,448,967	168,271	846,227	1,771,152
Missouri	158,400	694,700	626,708	1,695,481	816,350	124,785	754,897	1,696,032	1,596,319	335,130	3,583,378
New Mexico	25,200	119,000	101,991	269,556	24,751	19,530	212,040	256,321	6,122	183,271	194,398
Oklahoma	59,200	377,200	109,100	1,205,831	334,858	86,908	792,074	1,213,840	129,835	98,088	1,346,678
Texas	152,300	1,091,100	532,786	4,115,346	212,471	94,694	3,808,843	4,116,008	276,797	151,385	4,773,544
Total	535,100	3,578,900	1,774,651	12,116,152	2,277,664	619,706	9,254,633	12,152,003	2,957,197	2,135,862	14,712,138

[1] Generating capacities as reported in Edison Electric Institute Bulletin of December 1941.
[2] Includes all energy generated for public use.
[3] Includes all energy generated for public use, except that from plants supplying less than 10,000 kw.-hr. per month. Also includes production of electric energy by electric railways, electrified steam railroads, and public owned noncentral stations.

Source: Federal Power Commission data, except as noted.

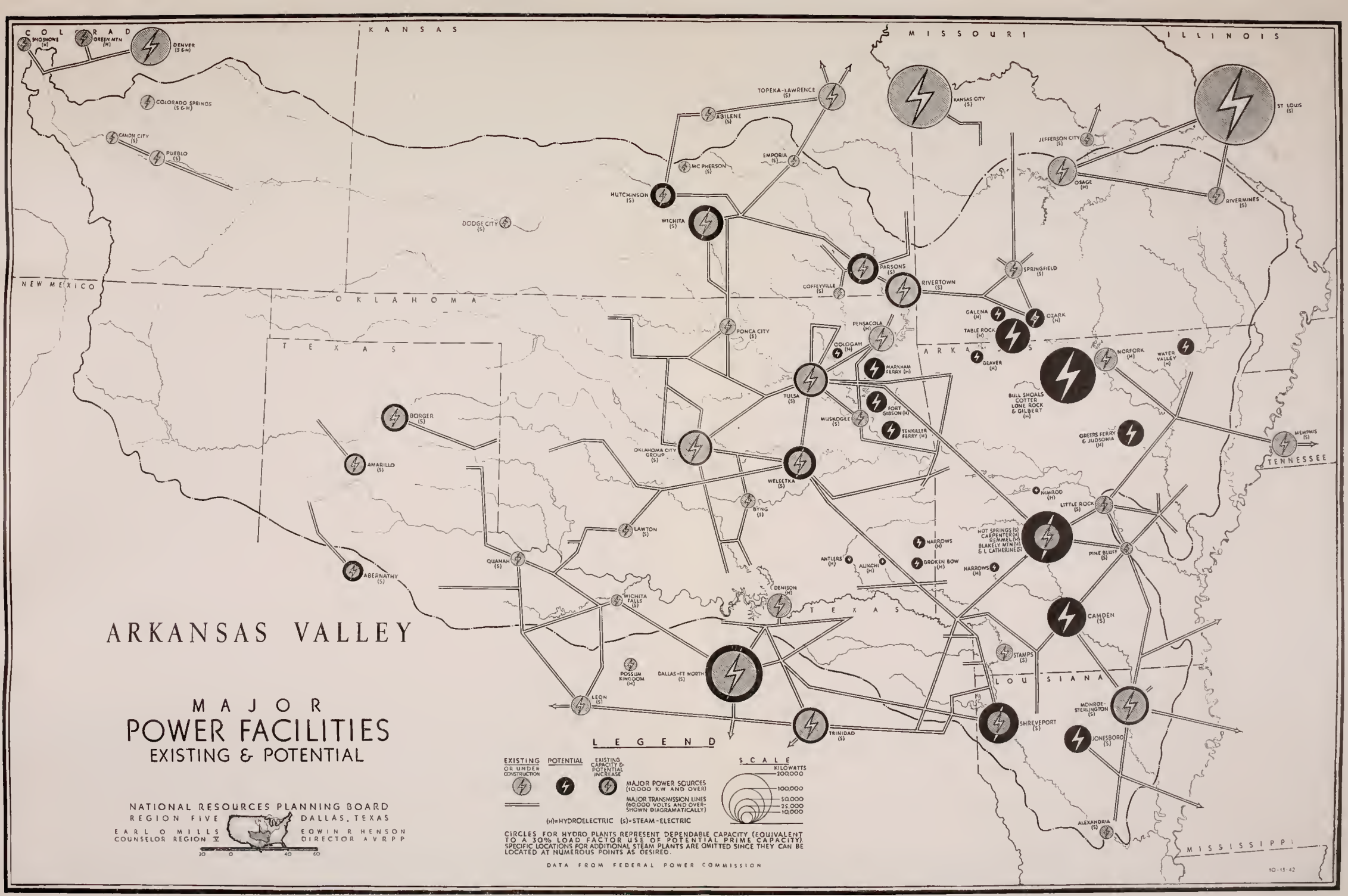

FIGURE 11.

(Face p. 74)

In its report of July 16, 1941, to President Roosevelt, the Federal Power Commission recommended the installation of 315,000 kilowatts in steam-electric plants in Arkansas, Louisiana, Kansas, and the Texas Panhandle, some of this capacity being in new plants and some in existing plants, such as the Riverview plant of the Panhandle Power and Light Co., and the Arsenal Hill plant of the Southwestern Gas and Electric Co. These plants, located respectively at Borger, Tex., and Shreveport, La., are included in table 21, which summarizes the location of new steam-electric generating capacity proposed or contemplated in the region. Other locations proposed in the Federal Power Commission's report are also shown in table 21, along with locations for potential expansion of existing plants or construction of new plants reported to the Federal Power Commission by electric utility companies.

Some of the installations being made by the utilities are alternates to plants suggested by the Federal Power Commission. However, some 500,000 kilowatts could be provided through expansion of existing plants. Undoubtedly many other sites are available for the location of additional steam-electric capacity, but actual determination of the site must necessarily await the need for the capacity. Such plants could be located with greater latitude in the eastern part of the region than in the western part, where available condenser-water supply would be one of the principal limiting factors.

Hydroelectric Projects

Many of the most attractive water-power sites between the Mississippi River and the Rocky Mountains are located in this area, but less than 7 percent of the full potential power possibilities has been developed. In recent years, particularly since the passage of the 1938 Flood Control Act, the Corps of Engineers, United States Army, and the Federal Power Commission have given considerable study to this problem, and, although the full power potentialities of the Valley have not yet been exhaustively explored for all possible sites, completed surveys and studies have disclosed a large number of sites that are economical of development.

1. *White River.*—As is indicated by the large number of potential projects on the White River in Missouri and Arkansas, this basin is the largest potential source of hydroelectric power supply in the region. Outstanding projects are the Norfork project, now under construction, and the Table Rock and Bull Shoals projects proposed for early construction. These may be classed as multiple-purpose projects in that they provide for flood control and other uses, in addition to the development of power. Some of the remaining projects in the White River basin will be developed for power only, although incidental conservation and recreation benefits will result. These projects would be made feasible by the river regulation afforded by such projects as Table Rock and Bull Shoals and should be operated in conjunction with these as integral parts of the comprehensive basin development plan.

TABLE 21.—*Location of new steam-electric generating capacity proposed or contemplated in the region*

EXISTING PLANTS

Location:	*Potential capacity additions kilowatts*
Riverton, Kans.[1]	25,000
Hutchinson, Kans.[1]	30,000
Parsons, Kans.*	40,000
Wichita, Kans.*	50,000
Oklahoma City, Okla.*	20,000
Tulsa, Okla.*	20,000
Weleetka, Okla.*	42,500
Borger, Tex.[1]	20,000
Amarillo, Tex.*	12,500
Abernathy, Tex.*	25,000
Trinidad, Tex.*[2]	25,000
Dallas, Tex.*	94,000
Shreveport, La.[1]	60,000
Sterlington, La.*	30,000
Total	494,000

NEW PLANTS

Location:	*Installed capacity kilowatts*
Near Stamps, Ark. (McKamie)*	25,000
Camden, Ark.[1]	120,000
Near Shreveport, La. (Caddo Lake)*	25,000
Jonesboro, La.[1]	60,000
Total	230,000

*As reported to Federal Power Commission.

[1] Proposed in Federal Power Commission Report of July 16, 1941, to the President.

[2] Land and cooling water facilities are sufficient for much larger capacity.

2. *Arkansas River.*—The four projects on this river included as potential sources of hydroelectric power would generate over 2 billion kilowatt hours annually, a block of energy almost as great as the total potential shown for the entire White River Basin. Because of the adverse social and economic effects that would result from inundation of the large areas of productive bottom land by these projects, it is doubtful if they should be constructed even if the immediate benefits would substantially exceed the annual costs. However,

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Amarillo, Tex.*	12,500
Abernathy, Tex.*	25,000
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they cannot be overlooked when considering the hydroelectric power possibilties of the area.

3. *Grand (Neosho) River.*—This Oklahoma river, a tributary of the Arkansas, offers the next largest source of hydroelectric power in the region. The Pensacola project has already been constructed in this basin and the Markham Ferry and Fort Gibson projects are proposed for early development.

4. *Upper Arkansas River.*—Irrigation and flood control are of primary importance in this basin, but transmountain diversions from the upper Colorado River watershed that may include power development are under investigation. In such tributary basins as the Cimarron and Canadian, the principal problems are flood control, drought, and pollution, and there are few power possibilities.

5. *Red River.*—Although there is a possibility of an average annual output of about 1,400 million kw.-hr. from this basin, it does not appear to offer as many attractive sites as have been found available on some parts of the Arkansas River and the White River. The possibilities that do exist are in the lower part of the basin, and it is likely that power will in most instances be developed in conjunction with flood control.

6. *Ouachita River.*—Two plants (Remmel and Carpenter) have been constructed on this river by a private utility company, and a third site in this series (Blakely) is now under consideration for development as a federally owned multiple-purpose project. Another project (Narrows), on the Little Missouri River in this basin, has been found to be economically feasible for development for flood control and power purposes. Other sites are known to be available, but no extensive studies of them have yet been made.

Total hydroelectric power possibilities.—A summary of the projects on which reasonably reliable estimates are now available is given in table 22, which indicates that the hydroelectric power possibilities of the region, segregated according to degree of development, are as follows:

Items	Estimated prime (continuous) power, kw.*	Estimated average annual, output million kw.-hr.
Completed projects	20,800	488.0
Projects under construction	30,900	424.1
Potential projects	468,690	6,493.0
Total	520,390	7,405.1

*Continuous power is that capable of being produced 24 hours a day, 365 days a year, under the most adverse conditions of stream flow.

Coordinated Use of Hydroelectric and Steam Power

The predominance of fuel-burning plants in the Valley makes it possible to utilize the relatively small amount of hydroelectric capacity on the peaks of the area or regional load curves, and for that reason installations at hydroelectric projects have been made at relatively low annual plant factors. This utilization of hydroelectric capacity is both effective and economical.

During periods of good run-off when the water supply is in excess of that required for purely peak load operations of hydroelectric plants, the surplus energy is in most cases fully usable to conserve fuel in steam-electric or Diesel plants and is usually available at relatively low cost.

Such Federal projects as Pensacola, now in operation on the Grand River; Denison, now under construction on the Red River; Norfork in the White River Basin; and the private projects on the Ouachita River (Carpenter and Remmel), may be considered to be peak load plants for operation at low annual load factors. It is also expected that as long as the load shape permits, most of the other hydroelectric projects in the region listed in table 22 will be constructed for ultimate operation as low-load-factor generating plants. It must be recognized, however, that unless steam-electric capacity maintains a reasonable predominance in the region as a whole, the aggregate of hydroelectric capacity could eventually reach the point at which lower individual plant installations would be necessary in order that the capacity might be fully and economically utilized.

TABLE 22.—*Hydroelectric power possibilities in the Arkansas Valley (Red, Arkansas, Ouachita, White-Black-St. Francis Rivers)*

Basin	Project	Estimated prime (continued) power kw.	Estimated average annual output million Kw.-hr.
COMPLETED PROJECTS			
Arkansas (Grand Neosho)	Pensacola	15,500	300.0
Arkansas (Fourche La Fave)	Nimrod [1]	1,350	28.0
Red (Ouachita)	Carpenter	2,300	100.0
Red (Ouachita)	Remmel	1,350	
White (Main Stem)	Ozark Beach	300	60.0
Total		20,800	488.0
PROJECTS UNDER CONSTRUCTION			
Red (Main Stem)	Denison	14,000	215.0
Arkansas (Petit Jean)	Blue Mt.[2]	700	14.1
White (North Fork)	Norfork	13,200	145.0
White (Black)	Clearwater [2]	3,000	50.0
Total		30,900	424.1
POTENTIAL PROJECTS			
Red (Main Stem)	Gainesville	11,400	200.0
Red (Below Denison)	Miscellaneous projects	45,000	680.0
Red (Washita)	Miscellaneous projects	7,000	100.0
Red (S. E. Okla. Trib.)	Miscellaneous projects	9,400	175.0
Red (Ouachita)	Blakely	[3] 7,600	80.0
Red (Ouachita)	Narrows	2,050	24.0
Arkansas (Main Stem)	4 plants	120,000	2,120.0
Askansas (Grand Neosho)	Markham Ferry	10,500	145.0
Arkansas (Grand Neosho)	Fort Gibson	10,800	150.0
Arkansas (Verdigris)	Oologah	2,400	39.0
Arkansas (Illinois)	Tenkiller Ferry	8,700	120.0
Arkansas (Caney)	Hulah	840	10.8
White (Main Stem)	Table Rock	[4] 35,000	320.0
White (Main Stem)	Bull Shoals	[5] 55,000	550.0
White (Main Stem)	Beaver	4,000	42.0
White (Main Stem)	Cutter	12,500	125.0
White (Main Stem)	5 plants	50,000	700.0
White (Buffalo)	2 projects	19,000	229.0
White (Eleven Pt.)	Water Valley	6,700	83.0
White (Little Red)	Greer's Ferry	10,500	120.0
White (Little Red)	Judsonia	6,000	75.0
White (James)	Galena	5,000	50.0
White (Current)	Blair Creek	11,500	128.8
White (Current)	Doniphan	11,500	128.4
St. Francis	Marble Creek	3,000	47.0
St. Francis	Rowland Church	3,300	51.0
Total		468,690	6,493.0
Grand total		520,390	7,405.1

[1] Completed for flood control only. Penstocks provided for power development.
[2] Now being constructed for flood control and allied problems, but without present power facilities.
[3] Includes benefit to Carpenter & Remmel.
[4] Includes benefit to Ozark Beach.
[5] With Table Rock in operation.

Although preliminary estimates of the installed capacities at several of the potential hydroelectric projects summarized in Table 24 have been made, the actual generating capacity installed at any individual project or group of projects will depend upon the extent, location, and characteristics of the power load expected to be served at the time the power plants are constructed. However, from the over-all standpoint, the magnitude of the possible total hydroelectric installations in the region can be shown by application of a range of possible average plant factors (for the entire group of projects) to the aggregate potential prime or continuous power available. The installed capacities for a range of plant factors from 20 percent to 50 percent would be approximately as follows:

Average (Annual) plant factor:	*Installed capacity, kw.*
20%	2,600,000
30%	1,700,000
40%	1,300,000
50%	1,040,000

Limits of Hydroelectric Power Developments

In the foreseeable future it appears that steam generation will always be the major source of electric energy. Without an increase in steam generation, full development of hydroelectric power would account for about 40 percent of the energy used annually within the area. Such an expansion of hydroelectric power generation without a corresponding increase in steam generation is not likely, but its mention illustrates the

limitations of hydroelectric power development in relation to the total energy needs of the region. It is believed that the energy generated from hydroelectric power plants will never exceed more than 25 or 30 percent of the total energy required.

Power Markets

Present Markets

Although the power developed at hydroelectric projects or at fuel-burning plants might be expected to be used primarily for the development of the Valley itself, the widespread transmission networks already in operation to serve the many existing electric power systems there make it necessary to think in terms of a market beyond the confines of the Valley.

The Federal Power Commission has divided the country into 48 "power supply areas" which include a group of transmission systems that either are now interconnected or could be interconnected and coordinated. In many instances the systems within each of these power supply areas are further interconnected with systems in adjacent areas. For convenience, as well as for effective consideration of the power supply and power market problem in the region tributary to the Valley, power supply areas listed in Table 23 may logically be considered to comprise most of the area in which new power developed there might be marketed.

The relationship between the estimated dependable generating capacity and annual peak demand on the major systems in each of these areas in 1942 is shown in Table 23. These estimates of peak demand contain a substantial increment of load occasioned by the war program. The area totals are the sum of estimates furnished the Federal Power Commission by the utility systems.

Although the figures shown in Table 23 indicate a possible surplus of capacity in several of the power supply areas under consideration, it is quite probable that by the end of 1943 all available generating capacity in the entire Valley will be fully loaded in order to meet the annual system peaks, and that only in rare cases will any reserve capacity be available for possible equipment breakdown.

In fact, it may become necessary to impose on the region some form of load control and curtailment of civilian use in order to assure an adequate power supply for its many and important war loads. There would undoubtedly be an immediate market for any additional capacity that could be made available beyond that now scheduled; but in the allocation to this region of new generating equipment, consideration must be, and is being, given to its relative place in the Nation's over-all war program.

Future Markets

In these uncertain times it is difficult to forecast accurately the future power loads on the major electric systems in the region. The location here during the war period of numerous heavy-power-consuming industries, particularly electrochemical, electrometallurgical, and munitions plants, has necessitated a rapid and large increase in generating capacity both in the utility systems and in private or government plants. Most of these additions have been in steam-electric capacity.

The extent to which this capacity may be available for future normal uses in the region will depend upon the future use that is made of the war plants for which

TABLE 23. *Dependable capacity and peak demand*

[Class I electric utility systems]

Line No.		Dependable capacity [1]—kw.			Peak demand [2]—kw. 1942		Dec. 1942 required reserve, kw.	Peak demand [2]—kw. 1943, estimated December	December 1943 required reserve, kw.
		Actual September 1942	Estimated December 1942	Estimated December 1943	Actual September	Estimated December			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1	Power Supply Area 25 (Arkansas; Northern Half and Delta Area of Louisiana; and Western Half of Mississippi.)	376,563	376,563	501,563	333,520	400,000	35,100	435,600	35,100
2	Power Supply Area 33 (Oklahoma, Except Panhandle.)	358,893	363,893	383,983	284,700	305,000	37,576	350,000	37,576
3	Power Supply Area 34 (Southeastern Kansas and Southern Missouri.)	186,870	186,870	186,870	154,900	168,300	22,550	185,600	22,550
4	Power Supply Area 36 (Texas Panhandle.)	97,084	116,284	116,284	59,100	75,700	21,107	79,600	21,107
5	Power Supply Area 37 (Northern Texas, Except Panhandle.)	595,534	596,734	656,734	457,700	504,620	64,225	548,330	64,225

[1] Net firm power purchases are included in Dependable Capacity.
[2] Area peak demands are non coincident.

they were provided. Only in the event that these war industry plants are abandoned, or their operations materially curtailed instead of being diverted into peacetime uses requiring an equivalent amount of power, would they provide any considerable power supply for the general industrial development of the Valley and the much needed expansion of domestic and other normal uses.

Experience in other areas, where large blocks of additional power supply have been provided in spite of contentions that no market would be available, indicates that even if some of the war loads in the Valley were discontinued, power hitherto made available for them would be rapidly absorbed elsewhere. Rather than being a burden on the region, this energy resource should offer an inducement to, and provide an opportunity for, a regional industrial expansion that otherwise might not take place.

Development of the natural resources and industrial organization so necessary to general economic improvement in the Valley cannot be expected to precede, but must follow, the development of electric power. In the formulation of a near-future, as well as a long-range plan for the Valley, there need be no fear of a surplus of power, even though a short period of readjustment may be necessary immediately following the war.

The possibilities of future use of electric power in homes, farms, industries, mines; in the utilization of forest products; and in the enlarged commercial uses that would parallel these, would result in annual power requirements far in excess of the capacity of existing facilities. The availability of power and the adoption of progressive rate policies which would result in providing power at low rates, would furnish the impetus for and be the key to such enlarged use.

With a view to measuring the prime need for additional generating facilities, a study has been made of what these electric energy requirements would be. The results demonstrate that an intelligent plan for the construction of new steam and hydroelectric facilities is essential and must be undertaken if the Valley is even to approach its possibilities for all-around development.

Requirements for Electrical Energy

Those parts of the plan for the development of the Valley which have a direct bearing on power requirements are concerned with the expansion of industry, the goal of full employment at fair wages, and anticipated population shifts from rural to urban centers. All three factors will bring about a greatly increased use of electricity.

Power Market Area

The electrical energy requirements estimated for the Valley apply to an area which is not exactly coterminous with it. The region selected comprises the Federal Power Commission Power Supply Areas Nos. 25, 33, 34, 36, and 37, which include parts of Louisiana, Mississippi, and Texas not in the Valley, and exclude those parts of Colorado and New Mexico which are in the Valley.

This region was selected because (1) it more nearly represents the market area for the power to be developed in the region, (2) present operations of integrated utility systems more nearly fit it, (3) reports of operating companies and the Federal Power Commission are available for this area, and (4) a definite estimate of the necessary capacity can be made.

Break-down of the Power Market

Electrical energy requirements in the Power Market Area have been classified as: (1) farm, (2) domestic, (3) commercial, (4) industrial, (5) mining, and (6) other.

1. *Farm consumers.*—The plan for meeting energy requirements in the Valley should provide for a 70–80 percent electrification of the farms. On the basis of this estimate, the number of farm families to be planned for in the Valley power program would total 450,000.

Since a farm is a combination of residence and productive enterprise, it utilizes both electric light and small-power facilities. From the standpoint of the residence, the farmer has a greater need for electrical energy than the urban resident because more of the family services, such as water pumping, laundry, cleaning, and other tasks are performed in the home. Also, since the farm family is likely to be larger than the urban family, it requires more refrigeration capacity.

In addition to home use, a multitude of uses for electricity can be found in the farm plant itself. Recent engineering studies indicate the potential uses and requirements for electric energy on different types of farms. These studies (which cover only uses in farm operations) show the following annual consumption of electrical energy:

	kw. hr./year
(a) Dairy farm—50 acres; 20 cows; feed grown on farm	12,320
(b) Truck farm—50 acres	4,460
(c) Hog farm—50 acres; 250 hogs; feed grown on farm	6,780
(d) Fall crop farm—50 acres; cotton, grain, etc	2,390
(e) Diversified farm—50 acres; 10 cows, 30 hogs, 200 chickens; orchards; truck; feed grown on farm	5,845
(f) Chicken farm—50 acres; 1,000 chickens; feed grown on farm	4,150

West of the 98 meridian, there is a large irrigation section. In Arkansas there is also a substantial rice-growing area needing irrigation. Much of this irrigation requires pumping. In addition, many farms use partial irrigation for gardens and small orchards.

The regional plan provides for a minimum family income substantially above the current average. This would enable a larger number of farmers to have and freely use electric service.

Other factors which will stimulate an increased use of electricity on the farm are low rates and progressive rates policies. Likewise, the work of the Rural Electrification Administration and of rural electrification cooperatives in the area, together with wise guidance and education in the uses of electricity, will do much toward making the farmer an important power consumer.

The Valley should plan for an annual consumption of 4,000 kw.-hr. per farm. If 450,000 families used this much electric energy, the yearly total used would be 1,800,000,000 kw.-hr.

2. *Domestic consumers.*—A study of electric energy consumption by domestic users in the Power Market Area reveals an increase from 397 kw.-hr. in 1927 to 867 kw-hr. in 1941. The straight-line extension of this trend indicates an average annual consumption in 1953 of 1269 kw-hr. Even now, many communities have average annual rates much greater than this.

Domestic power rates are still very high in the Valley. For example, a monthly electric bill for 100 kw.-hr. in Knoxville, Tenn. (Tennessee Valley Authority area), is $2.50, as compared with $4.10 at Little Rock, Ark.; $4.40 at New Orleans, La.; $4.08 at Oklahoma City, Okla.; $4.20 at Tulsa, Okla.; and $4.18 at Amarillo, Tex. In smaller cities the rates are higher.

When additional power is developed in the Arkansas Valley, these rates can be brought into line with those now obtaining in Knoxville.

Considering these factors, and the probable increase in the income of the Valley, it is reasonable to assume that the straight-line trend of power consumption will be exceeded. While the exact amount of increase cannot be known, the Valley should plan for an average annual domestic use of 2,500 kw.-hr. For 1,950,000 families this means that domestic energy requirements per year would total 4,875,000,000 kw.-hr.

3. *Commercial consumers.*—Anticipated expansion in (1) wholesale and retail trade, (2) finance, insurance, and real estate, (3) business and repair services, (1) amusements, recreation, and related services, and (5) professional and related services, will probably create 160,000 new commercial consumers of power in the Valley. The total number of commercial customers in the power market area in 1941 was 224,850. Thus, the power needs of approximately 385,000 commercial consumers must be taken into consideration in planning a power program.

A study of the use of electric energy by commercial consumers in Arkansas, Kansas, Louisiana, Missouri, Oklahoma, and Texas, shows an increase in annual average use per consumer of from 2,804 kw.-hr. in 1927 to 5,726 kw.-hr. in 1941. The trended use thus indicated for 1953 is 7,879 kw.-hr.

Commercial electric rates in the Valley are exceptionally high. For example, the monthly bill for a commercial consumer with a 6-kilowatt demand and a 750 kw.-hr. use is $14.00 at Knoxville, Tenn., as compared with $34.50 at Little Rock, Ark.; $39.35 at New Orleans, La.; $32.83 at Oklahoma City, Okla.; $29.00 at Shreveport, La.; and $28.75 at Amarillo, Tex. The rates are higher in the smaller towns.

With the development of additional power, rates should be comparable with those at Knoxville. Such a reduction in rates would stimulate use of better and more adequate lighting, as well as of air-conditioning and small-power facilities, in excess of the normal trend, although it is difficult to estimate now the extent to which the normal trend might be exceeded. Giving proper weight to the factors involved, however, it is believed that the Valley should plan for an average annual use of 10,000 kw.-hr. per commercial consumer, or a total of 3,850,000 kw.-hr.

4. *Industrial consumers.*—The industrial plan for the Arkansas Valley provides for the employment of 230,000 additional workers in 18 different industries.

The requirements of *present* industry in the Valley and in the power market area outside the Valley trended to 1953 indicate an annual consumption of 3,326,000,000 kw.-hr. resulting in a total estimated energy requirement of 6,969,000,000 kw.-hr. annually.

Based upon the extension of the straight-line trend of energy requirements per man-hour in industry from 1929 to 1939 it is estimated that in 1953 the energy requirements of *new* industrial development will total 3,643,000,000 kw.-hr. Table 24 contains a detailed breakdown of this estimate.

5. *Mining consumption.*—If industrial development of the Valley takes the form now contemplated, 33,000 additional miners will be employed—coal miners, lead and zinc miners, and others.

The average consumption of electrical energy per coal miner in 1939 in Arkansas, Kansas, Missouri, and Oklahoma was 5,215 kw.-hr. On this basis it is estimated the energy requirements for the additional 18,000 coal miners will be 90,000,000 kw.-hr. per year. The average use of electrical energy per worker in the lead and zinc industry (including milling) in the Tri-State District (Oklahoma, Kansas, and Missouri) was 18,225

kw.-hr. in 1939. On this basis, the 6,500 new workers in lead and zinc mining operations will require 110,000,000 kw.-hr. per year. The remaining 8,829 workers in other mines will require an additional 25,000,000 kw.-hr. Thus, the total estimated amount of energy required for mining in the Valley is 300,000 kw.-hr. yearly.

TABLE 24.—*Estimated electric energy requirements for new industrial development contemplated in Arkansas Valley plan*

Industry group	Estimated new industrial wage earners [1]	Total annual wage-earner man-hours [2] (thousands)	Kw.-hr. consumption per wage-earner man-hour estimated			Estimated additional energy required 1953—1,000 kw.-hr.
			1929 [3]	1939 [3]	1953	
Food and kindred products	24,100	48,200	2.6	3.7	5.3	256,000
Textile-mill products	13,200	26,400		3.3	5.3	140,000
Apparel and fabricated textile products	23,500	47,000		0.3	0.5	24,000
Sawmills, planing mills, and logging	2,700	5,400	1.0	1.9	3.2	17,000
Furniture and miscellaneous woodwork	21,900	43,800	0.5	1.1	2.0	88,000
Paper and allied products	16,700	33,400	12.7	16.9	22.1	740,000
Printing, publishing, etc.	3,100	6,200	0.9	1.4	2.1	13,000
Chemicals and allied products	21,000	42,000	11.4	17.1	25.2	1,060,000
Petroleum and coal products	5,500	11,000	6.0	16.9	32.2	355,000
Rubber and rubber products	8,400	16,800	3.7	7.0	11.6	195,000
Leather and leather products	12,500	25,000	0.5	0.7	1.0	25,000
Stone, clay, and glass products	15,800	31,600	5.0	8.8	14.2	450,000
Iron and steel products	10,300	20,600	1.2	2.5	4.3	89,000
Nonferrous metals, etc.	4,900	9,800	3.4	5.5	8.4	82,000
Machinery	9,600	19,200	1.3	2.2	3.5	67,000
Automobiles and equipment	900	1,800	1.6	3.4	5.9	11,000
Other transportation equipment	1,200	2,400	1.0	1.5	2.2	5,000
Other manufacturing, etc.	10,800	21,600	0.7	0.9	1.2	26,000
Total						3,643,000

[1] Does not include mangerial or administrative workers.
[2] Hours of work per year assumed to be 2,000.
[3] Preliminary estimates based on data from U. S. Bureau of Census and Bureau of Labor Statistics.

6. *Other consumption.*—This is a classification which varies greatly from one utilities company to another. For purposes of this study, it includes electrical requirements for 79,000 additional workers in construction; 106,000 workers in transportation, communication, and other public utilities; 21,000 workers in industry not reported; and 25,000 Government workers. It also includes power requirements of present consumers in these designations. Energy consumption by these groups should reach at least 423,000,000 kw.-hr. by 1953.

Total Requirements

The following tabulation summarizes the anticipated electrical energy requirements for the planned development of the Arkansas Valley.

Types of use:	*Annual energy requirements (1,000 kw.-hr.)*
(a) Farm customers, 450,000 customers at 4,000 kw.-hr. each	1,800,000
(b) Domestic customers, 1,950,000 customers at 2,500 kw.-hr. each	4,875,000
(c) Commercial customers, 385,000 customers at 10,000 kw.-hr. each	3,850,000
(d) Industrial consumers' requirements (full trend new industry)	6,969,000
(e) "Other" customers, requirements	423,000
(f) Mining customers, requirements	300,000
Total requirements ultimate consumers	18,217,000
Estimated losses (20 percent)	3,653,000
Total requirements for loads	21,870,000

Supplying Needed Power Facilities

Over-All Requirements

Based upon the experience of utilities companies in the area, it may be assumed that the regional annual load-factor will be about 63 percent. This means an average generation during the year of about 5,500 kw.-hr. for each kilowatt of demand. Under these circumstances of load-factor and energy requirements, the peak demand upon the generating facilities would be 3,970,000 kw. This is about two and one-half times the peak demand which it has been estimated will be experienced in 1942.

Reserve Capacity

It is not sufficient merely to provide generating capacity equal to expected demand. For example, there may be limitations of cooling water supply which reduce the dependability of steam-electric units. Again, the age and mechanical deterioration of equipment may not permit operation at rated capacities; in the case of hydroelectric power, for instance, reduced stream-flow or a lowering of head due to floods may result in output less than generator capacity. These reduced capabilities are generally considered as dependable capacity, or capacity that can be depended upon to assist in carrying load at the time of system peak.

It is not sufficient either to provide dependable capacity just equal to the expected load. The difficulty in accurately forecasting future loads may lead to under-estimation of peak load, or totally unforeseen loads may develop. Accidents happen to mechanical equipment in spite of the most extreme care in maintenance. Utilities groups have found by experience, that, to meet these contingencies and still meet load requirements, a certain amount of dependable capacity must be held in reserve, the amount depending, among other things, upon the size, type, age, and location of the generating capacity, the relation of the utility to and the degree of interconnection and coordination with adjoining electric utility systems.

This excess of dependable capacity overloads varies considerably between systems. Because of the greater mechanical reliability of hydro equipment as compared with steam-electric units, systems which have a large part of their capacity in hydroelectric units normally need a lesser reserve capacity.

It has been assumed in this study that minimum reserves of 10 percent, or about 400,000 kw., should be provided. This would require a total dependable capacity of about 4,400,000 kw. to meet the estimated demand of 3,970,000 kw.

The existing and scheduled capacity available to meet this demand aggregates only 2,144,000 kw., as follows:

Type of use:	*Dependable capacity kilowatts*
Hydroelectric:	
Existing	261,000
Definitely scheduled	56,000
Total	317,000
Steam-electric:	
Existing	1,650,000
Definitely scheduled	177,000
Total	1,827,000
Grand total	2,144,000

Compared with a required dependable capacity of 4,400,000 kw., this indicates a potential deficiency in dependable capacity of 2,256,000 kw., if all existing generating equipment remains available to meet the estimated demands of the development program when they arise. Actually there will be inevitable retirements of equipment, particularly steam-electric, on account of wear and obsolescence, and the need for new capacity would be about 2,400,000 kw.

Hydroelectric Projects

The following summary shows the essential data with respect to the power features of the hydroelectric projects suggested as a part of the plan for power facilities.

Projects	Generating capacity		Annual output	
	Installed	Dependable	Minimum year	Average year
	Kilowatts	*Kilowatts*	*1,000 kw.-hr.*	*1,000 kw.-hr.*
Existing projects	303,000	273,000	401,000	760,000
Under construction	315,000	250,000	238,000	360,000
Proposed new projects	1,051,000	957,000	1,941,000	2,580,000
Total	1,669,000	1,480,000	2,580,000	3,700,000

These figures do not represent, in the aggregate, the ultimate in installation at the projects selected, nor the ultimate in the construction of hydroelectric plants in the region. The list excludes projects which without doubt will ultimately become a part of the development plan for the Valley. The list is preliminary and there is the probability that other projects not included will be constructed in lieu of some that are included.

The largest number of these projects are multiple-purpose (in most part for flood control and power) and they are concentrated in the easterly portion of the Valley where precipitation is generally adequate for agriculture and water supplies, obviating the need for irrigation.

Coincident with the development of hydroelectric power, provision should be made to insure that adverse effects on stream flow are minimized, even at the sacrifice of some power generation. These provisions would consist mainly of regulating pool fluctuations within as small a range as possible, and maintaining a sustained outflow sufficient to uphold necessary standards of stream flow downstream.

The determinations of the installed generating capacity shown have been made with consideration given to the requirements of stream flow in the valleys below the projects. Because of this and other considerations the relation of the dependable capacities to the primary or continuous output capabilities varies materially between the projects.

In the aggregate, the annual load-factor in years of minimum stream flow would be about 20 percent when the generation reached 2,580,000,000 kw.-hr. On the average, these projects would produce 3,700,000,000 kw.-hr. and the average annual load-factor would be about 28.5 percent. In other words, the generation per kilowatt of dependable hydro capacity in a minimum water year would be about 1,750 kw.-hr., and about 2,500 kw.-hr. in an average water year, as compared with an entire area use of about 5,000 kw-hr. per kilowatt of total dependable capacity, steam and hydro.

This in no manner detracts from the value of the hydro in assisting in meeting regional loads, but results in the most economical use of both the steam and hydroelectric equipment, each of which has its greater value, normally, when utilized in coordination with the other.

Thus, the hydroelectric power would be utilized generally for carrying the daily and seasonal variations in load, permitting the steam capacity to operate at higher capacity factors, or more continuous hours of use, a condition which results in the greatest economy in the use of steam-electric equipment. In years of average or above-normal stream flow, however, it would be found advantageous to use these hydro projects to assist in carrying the steady base load, utilizing the less efficient of the steam generators in the short duration peaks.

The order in which the potential hydroelectric projects listed in Table 25 may be constructed cannot now be determined, but several of them are sufficiently attractive to indicate the desirability of their early development. In addition to the Nimrod (completed for flood control), Denison, and Norfork (under construction) projects, the Federal Power Commission, in a letter dated July 16, 1941, recommended to the President that the following projects be scheduled for early con-

struction in order to assure an adequate power supply for the war program:

River	Project	State	Installed initial capacity	Date of completion
			Kilowatts	
Arkansas	Markham Ferry	Oklahoma	30,000	1943
Arkansas	Fort Gibson	Oklahoma	30,000	1943
White	Bull Shoals	Arkansas	110,000	1945
White	Table Rock	Missouri	60,000	1946
			230,000	

Provisions are being made at the Denison and Norfork Projects, now under construction with initial installations being made of 70,000 kilowatts and 60,000 kilowatts, for the future installation of an additional 105,000 and 60,000 killowatts, respectively. But from the standpoint of a power supply for the relatively high load-factor requirements of the war program, advantage should be taken of the potentialities of such projects as Bull Shoals, Table Rock, Markham Ferry, and Fort Gibson, before these expansions are made.

The geographic location of these hydroelectric projects is important particularly with reference to the interests of the upper and lower basin states. They are all located east of the 98th meridian and, except for Denison, are so situated that the other uses of water in the upper basin states could not in any manner affect them. This fortunate geographic location of hydroelectric projects will permit the full development of the water resources of the upper basin for irrigation and allied uses and of the lower basin for generation of electrical power and other uses, with no conflict between the primary interests of either basin.

TABLE 25. *Hydroelectric projects included in Arkansas Valley plan*

EXISTING PROJECTS

River basin	Stream	Project	Purpose [1]	Primary output		Generating capacity kilowatts		Average annual output (1,000 kw.-hr.)	Recommended minimum sustained downstream flow c.f.s.
				Continuous Kilowatts	Minimum year (1000) kw.-hr.	Installed	Dependable		
1	2	3	4	5	6	7	8	9	10
Red	Ouachita	Carpenter	P	3,650	32,000	65,000	65,000	100,000	75
Do	do	Remmel							
Arkansas	Grand	Pensacola	P-FC	15,500	136,000	75,000	60,000	300,000	*
White	White	Ozark Beach	P	300	3,000	[2] 28,000	[2] 28,000	60,000	*
Colorado (of Texas)	Colorado (of Texas)	Four Projects	P-FC	26,200	230,000	135,000	120,000	300,000	..
Brazos	Brazos	Possum Kingdom	P						
Total existing				45,650	401,000	303,000	273,000	760,000	..

PROJECTS UNDER CONSTRUCTION

White	North Fork	Norfork	P-FC	13,200	116,000	[3] 140,000	[3] 120,000	145,000	*
Red	Red	Denison	do	14,000	122,000	[3] 175,000	[3] 130,000	215,000	*
Total under construction				27,200	238,000	315,000	250,000	360,000	..

PROPOSED NEW PROJECTS

Arkansas	Fourche LaFave	Nimrod [5]	P-FC	1,350	12,000	14,000	14,000	28,000	25
Do	Grand	Ft. Gibson	do	10,800	95,000	35,000	30,000	150,000	*
Do	do	Markham Ferry	do	10,500	92,000	60,000	55,000	145,000	*
Do	Illinois	Tenkiller Ferry	do	8,700	76,000	50,000	45,000	120,000	*
Do	Verdigris	Oologan	do	2,400	21,000	12,000	12,000	39,000	2.00
White	White	Table Rock	do	[4] 35,000	[4] 305,000	100,000	90,000	326,000	*
Do	do	Bull Shoals	do	[6] 55,000	480,000	170,000	140,000	550,000	*
Do	do	Cotter	P	12,500	110,000	35,000	30,000	125,000	*
Do	do	Beaver	do	4,000	35,000	20,000	26,000	42,000	*
Do	James	Galena	do	5,000	43,000	25,000	25,000	50,000	*
Do	Eleven Point	Water Valley	P-FC	6,700	59,000	42,000	36,000	83,000	10
Do	Little Red	Greer's Ferry	do	10,500	92,000	50,000	50,000	120,000	15
Do	do	Judsonia	P	6,000	53,000	30,000	30,000	75,000	15
Do	Buffalo	(2 projects)	P-FC	19,000	167,000	90,000	90,000	229,000	*
Ouachita	Ouachita	Blakely	do	[7] 7,600	67,000	120,000	120,000	80,000	75
Do	Little Missouri	Narrows	do	2,050	18,000	30,000	30,000	24,000	25
Red	Tributaries (below Denison)	(4 projects)	do	9,400	82,000	50,000	50,000	175,000	10
Brazos	Brazos	do	do	15,000	134,000	118,000	90,000	225,000	..
Total proposed new projects				221,500	1,941,000	1,051,000	957,000	2,580,000	..
Grand total				294,350	2,580,060	1,669,000	1,480,000	3,700,000	..

[1] P, power; FC, flood-control; I, irrigation.
[2] Existing installation, 4 4,000 kw. units.
[3] Initial installation scheduled for 1943, 1 unit of 35,000 kw. generator capacity.
[4] Includes benefit to existing Ozark Beach plant.
[5] Under construction for flood control.
[6] With Table Rock in operation.
[7] Includes benefit to existing Carpenter and Remmel plants.
* Stream flow conditions would be satisfactory under any probable operation.

The following summary shows how the estimated development load of 3,970,000 kilowatts would be served, utilizing these hydroelectric projects as set forth in Table 25, and by existing and new steam-electric facilities:

Type of Use	*Dependable capacity, kilowatts*
Hydroelectric:	
Existing	261,000
Under construction, initial installations	56,000
Proposed:	
Additions to projects existing and under construction	206,000
New projects	957,000
Total	1,480,000
Steam-electric:	
Existing and scheduled	1,827,000
Less retirements	140,000
Total	1,687,000
New steam-electric	1,203,000
Total steam-electric	2,890,000
Total dependable capacity	4,370,000
Less reserves	400,000
Net assured capacity required to meet load requirements	3,970,000

Steam-Electric Capacity

Table 21 summarizes some of the locations of new steam-electric generating capacity which could be installed to supply the additional 1,203,000 kilowatts of steam-electric capacity needed in the Valley. The total capacity of the plants shown in table 21 is somewhat less than that which is needed to meet the power requirements of the development plan for the Valley in conjunction with the new hydroelectric capacity suggested herein. There is, however, considerable latitude in the selection of sites for steam-electric plants and the list of such plants can easily be supplemented or amended as occasion requires.

The actual selection of the sites would have to await the need in order to place the new capacity as near to the load centers as is consistent with the availability of condenser-water supplies and of cheap fuel. The Valley is particularly fortunate in the wide availability of low-cost fuel—gas, oil, and coal—which, together with the development of the economical water power potentialities of the area as set forth herein, should make possible a low level of rates conducive to the rapid development of the Valley.

Looking Ahead

Considerable progress has been made in recent years, particularly as the result of the war emergency, in effecting transmission interconnections between utilities groups operating in the region. Facilities are increasingly being operated on a regional basis. As the development envisaged for the Valley progresses and new generating facilities, both steam and hydroelectric, are installed to precede and thus to keep pace with the growth in power requirements, additional transmission lines will have to be constructed. These transmission lines will include not only new facilities within the area but interconnections with adjoining areas in order to obtain for the region the optimum in power economics.

In order to assure sound planning of the future regional power program, steps should be taken toward the development of a comprehensive plan of regional coordination of operations of multiple purpose reservoirs, including flood control, irrigation, water supply, power production, interconnection of generating plants, and other related matters.

INDUSTRY

Out of a total population of 7,400,000, only 230,000 persons were gainfully employed in manufacturing industries in the Arkansas Valley in April 1940. By August 1942 this figure had been raised to approximately 350,000 by the addition of 121,000 workers in war plants. Nevertheless, only 12½ percent of the 2,400,000 persons gainfully employed in the Valley were engaged in manufacturing—notwithstanding the fact that the Nation is in the midst of the greatest boom period in its entire history, with the annual national income well over $100,000,000,000.

This Valley has perhaps the greatest array of natural resources and raw materials of any like area in the United States. Double or triple the present number of workers could be profitably employed in manufacturing industries if full employment of manpower and resources could be achieved and granted time for development.

The Arkansas Valley is still primarily a producer of agricultural and other raw materials, in spite of its tremendous industrial possibilities. It operates an extractive economy—agricultural and forest raw materials and minerals, its chief commodities, are sent, in large measure, outside the area for processing and finishing.

Studies demonstrate that low per capita incomes are directly associated with the percentage of the population engaged in extraction of raw materials. Mississippi and Arkansas, the two States lowest in per capita income, are highest in respect to the percentages of their populations engaged in the extractive industries.

In all 8 States of the Arkansas Valley the number of people engaged in raw material production exceeds the national average—9.5 percent—and all of these people earned less than the national average income in 1940.

Before the Valley can attain prosperity and security, measures must be adopted which call for the wise use and conservation of its exhaustible resources and which provide for further fabrication and processing within its boundaries. Industrialization is needed to furnish employment to the many unemployed and underemployed; to provide an opportunity for economic advancement; to raise per capita income; to provide more effective markets for the raw materials of the Valley; to give balance, variety, and stability to the economy. Industrialization is necessary if the 7,400,000 people of the Valley are to be full producers and full consumers.

Finally, there must be proper balance between manufacturing, agriculture, mining, construction, and the service industries. More manufacturing and service industries are needed to go with agriculture, forestry, and mining. Such a combination would help to make the economy healthier, stronger, and more productive.

Prospects for Industrial Development

Favorable Factors

Abundant minerals.—The description of the mineral resources in the section on Minerals of this report indicates the presence of 37 minerals in commercial quantities. The great quantities of natural gas, petroleum, coal, zinc, lead, iron, salt, other minerals, and building materials provide opportunities for expansion of manufacturing.

Approximately one-third of the petroleum and mineral reserves of the entire Nation are located here.

Agricultural products.—Agricultural and forest raw materials of the Valley are many and diverse. Large quantities of cotton, rice, sugarcane, sugar beets, wheat, corn, grain sorghums, broom corn, potatoes, peanuts, sweet potatoes, vegetables, fruits, dairy products, cattle, sheep, hogs, and poultry are produced. The forests contain vast quantities of a variety of soft and hard woods.

Fuel resources.—The Valley is also provided with many kinds of fuel, chief among them being petroleum, natural gas, natural gasoline, bituminous coal, and lignite. Plenty of coking coal is available. The reserves of these fuelstuffs are very large.

Power possibilities.—The power resources of the Arkansas Valley are amply large, far larger than any projected industrialization is likely to require. An analysis of these resources in the sections of this report on "Power" leaves no doubt that hydroelectric developments, together with a balanced use of low-cost fuels by steam, Diesel, and other internal-combustion methods, can supply industry, farms, and domestic users with ample electrical power at favorable rates.

Labor supply.—The population of the Valley can provide an ample number of young, eager workers who have the capacity to learn complicated skills and the desire to do creative and productive work. This labor supply is one of the area's greatest assets. Employment on war construction and production jobs, plus service in the new mechanized armed forces, will provide training and work experience for thousands of persons who will fit well into the future industrial pattern of the Arkansas Valley.

Transportation facilities.—The railroad, truck, bus, and airplane carriers of the Valley are adequate to take care of considerable industrial expansion. The railroad network covers the area adequately, while the highway systems are constantly being improved. Improvement of water transportation in the eastern portion of the Valley may come with any marked development in that section.

Water supply.—There is a supply of soft water sufficient to allow considerable industrialization. East of the 98th meridian, which runs roughly north from Wichita Falls, Tex., there is ample water of good quality. This is true also in portions of Colorado. While the water supply is limited in the Texas Panhandle, it will permit some industrial expansion if properly conserved.

A new local market.—The 7,400,000 people in the area have a vast need for a great many of the common necessities of life. Once these people are absorbed into the productive process, they will have the income with which to satisfy their needs. A well-developed industrial program would bring an increase of $1,750,000,000 or more in yearly expenditures for housing, food, clothing, health, and services.

Other significant factors.—For the past 15 years or more, the Southwest has gained much more rapidly in industrial production than many of the older areas.

The Arkansas Valley is in an unusually favorable position with regard to the new synthetic, chemurgic, and chemical industries because of its great variety and quantity of minerals and of vegetable, animal, and forest raw materials. This area has the Nation's largest supplies of petroleum and natural gas, from which can be made high-octane gasoline, synthetic rubber, safety glass, and plastics. It has vast stores of coal which can be converted into nylon, drugs, acids, dyes, and plastics.

The forest raw materials and cotton can furnish large quantities of cellulose for conversion into rayon or into cellulose plastics.

Now that satisfactory synthetic glues have been produced, there is a big field for the use of plywoods in

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manufacturing prefabricated houses, airplanes, furniture, boats, and building materials. Wastewood and sawdust can be converted into lignin plastics and moulding compositions, waste farm products such as oat and rice hulls, corn cobs, and corn and cotton stalks, can be converted into furfural which is used in making plastics and resin-bonded abrasive wheels, and in refining gasoline and lubricating oils.

Soybeans, which are being produced in increasing quantities in this region, are being converted into a host of moulded plastics and synthetic textiles. Casein plastics useful in the production of many products can be made from skimmed milk. Sugar-cane stalks can be made into wall board. Similar developments in chemurgy are bringing out new uses for peanuts, castor beans, and similar products. Starch can be obtained from the sweet potato. Tung oil can be extracted from the tung nut. Great possibilities exist for this area in the dehydration and quick freezing of vegetables, fruits, and eggs. Dehydration, especially of sweet potatoes, eggs, and milk, is already developing into a significant industry.

Obstacles

With all the undoubted advantages which the Valley possesses as an industrial area of great potential importance, there are nevertheless certain obstacles to early and complete industrialization.

Freight rates.—Many businessmen believe that the unfavorable interritorial freight rate differentials are one of the major handicaps to industrialization in the Arkansas Valley. The outward freight rates on raw materials are extremely low, tending to encourage exportation of its agricultural, forest, and mineral raw materials. Extremely high outward freight rates on finished commodities make it difficult for the local industry to compete in outside markets.

Lack of leadership in manufacturing industry.—While the Valley has strong industrial leaders engaged in the production of oil, gas, lumber, cotton, etc., it has not developed a corresponding leadership in manufacturing industry except in refining.

As the obstacles to new manufacturing industries are removed there is a growing need for aggressive leadership in this field to supplement that now engaged in the Valley in the production of raw materials. More emphasis must be given to training the young ambitious men and women in manufacturing for service in the Valley.

Lack of capital.—The lack of "venture" capital, and the high price of the capital that is available, together form a major obstacle. Most of the capital of the Valley is invested in land, forests, or mineral deposits, leaving little for the development of new industries. Much of it is "outside" capital which has been invested in facilities to extract raw materials and minerals.

The stringency of capital is revealed by the fact that, except for petroleum and mineral development, most industries in the area use much labor and little capital. Unfortunately, most of these industries are low-wage and low-value-creating industries. High wages and high productivity are associated with adequate capital investments. The tools, equipment, machinery, and processes of production used in the Valley are frequently depreciated and obsolete.

Lack of trained and experienced workmen.—New plants have usually brought in a nucleus of trained workers from other areas. This was especially true of the new war plants located in the Valley. However, once this nucleus was provided, local workers were taught the skills necessary to carry on, as is demonstrated by the experience of the airplane and shipbuilding industries. It is clear that the labor of this Valley does not lack talent, that it wants only the opportunity to put the talent it possesses to effective use. The war will help greatly in rectifying this situation, since workers in defense plants and soldiers in the new mechanized armies are acquiring skills now that will be invaluable in peacetime production.

Inadequate local markets.—The majority of people in the Valley have not had the income to buy the goods that could be produced locally. This difficulty is only temporary, for the basis of consumption—need—is there. Once the people are given productive work, they will have the income with which to meet their needs. This will open up a very large consumer goods market in the Arkansas Valley for the producers of the area.

Exploitation of raw materials.—The ease of obtaining wealth through the extraction of petroleum and minerals has obstructed industrialization by tending to discourage the more difficult, although more widely helpful, method of creating wealth through the processing and fabrication of agricultural, forest, and mineral raw materials. Skimming the vast stores of petroleum and minerals has prevented industrialization also by depleting these resources. It is difficult and expensive to take up development at this point; in some cases the base for solid industrialization that once existed has been lost. It is imperative, therefore, that raw materials and mineral resources be wisely used and conserved in order that they may provide the basis, not for quick profits alone, but for permanent industrialization.

Limits on production to protect prices.—The whole principle of controlling production to maintain better prices has been an important factor in preventing productive employment in the Arkansas Valley, as elsewhere.

Other obstacles.—Impediments to industrialization are found also in competition from established producers, lack of adequate distribution facilities and market contacts, interstate trade barriers, patent controls, and insufficient industrial research. Some of these might be eliminated, some might prove to be beyond reach; but all make more difficult the way of the agricultural region which seeks a measure of industrialization as a means of balancing its economy.

An Approach to Industrial Develpment

Certain modifications must be made before widespread industrial development may be expected to come to the Arkansas Valley.

Revision of the Freight Rate Structure

Revision of the present interterritorial freight rate structure must be undertaken if the Arkansas Valley is ever to specialize industrially in accordance with the principle of comparative advantage in production. Some export industries must be established and this Valley cannot maintain export industries in the face of the present freight rate differentials. To the degree that the Valley takes an important part in the new chemurgic, chemical, plastic, and synthetic industries, the rate structure for this new business will likely be satisfactory.

"Venture" Capital

Large amounts of capital at low rates of interest will have to be made available to producers. Where large profits can be made, outside capital rushes in; where the profits are less, the region is almost entirely dependent upon local capital. As such capital is comparatively limited, producers with sound ideas frequently cannot obtain capital at any price.

Electric Power

The expansion of electric power in the Arkansas Valley is vital to the further industrialization of the region. This expansion is entirely feasible in the Arkansas Valley through a fortunate combination of potential water power from the streams and the presence of readily available low cost fuels. The development of this power in abundance will be a great force in furthering industrial development. A portion of this great power will come with the multipurpose development of the streams for flood control, navigation, water supply, irrigation, recreation, and hydroelectric power; the remainder is available through the expansion of existing or the development of new private or public fuel generating plants.

Industrial Research

An industrial research council and laboratory is highly desirable in the Valley. The Federal Government does a great deal of research for the farmer and for the wholesaler and retailer; but the industrialist, particularly the small industrialist, is neglected. To fill this gap, the proposed laboratory would engage in practical experimentation and research directed toward production of new commodities from materials already well known, as well as the production of commodities now in common use from new materials. Such research would also be directed toward determination of the feasibility of technological innovations. Its job would be to find ways of turning out a superior-quality product at a lower production cost, as well as to discover new products and new methods of production.

Once it was determined that a process was physically possible at the laboratory level, it would be necessary to set up a pilot plant to demonstrate its practicability in actual production and to determine the costs of production. Thus the laboratory would be a place where enterprising persons could test their ideas; if these ideas proved to be technically and economically sound, they could secure financial assistance from some private financial agency or from one of several Federal agencies.

Regional social and industrial research councils would be of great help in bringing about desirable social and industrial changes in the Arkansas Valley. Such a council would be a policy-making organization set up to coordinate, formulate, and encourage intelligent planning and research among the various institutions of the region. Its membership would be drawn from State colleges and universities, State departments of government, and other interested agencies and would collaborate with the research departments of private companies.

By mobilizing all of the research talent upon a limited range of problems, a great deal could be accomplished. The council would specialize upon State and regional problems, concerning itself with matters of financing industry, taxation, marketing and distribution, importing and exporting, wage policy, training of workers and similar matters of broad concern. The council and the laboratory would not overlap in any way, but rather would complement each other. One of the first tasks of the council would be to prepare a program now that would insure the rapid conversion of war facilities in this region to peacetime uses after the war is over.

Cooperatives

When soundly developed and expanded through a suitable educational program, and firmly anchored to a base of consumer participation, cooperatives can greatly

implement the industrial program. They would help lessen the outflow of dividends and interest; further democratize economic ownership, production, and distribution; and increase participation in industrialization.

However, enabling legislation in the states where it is now too restrictive should be expanded so as to grant cooperatives broad power to engage in miscellaneous commercial, mining, construction, and manufacturing activities, and to furnish health services to members.

A number of industries seem particularly suitable as cooperative enterprises, since they could begin as relatively small businesses requiring a minimum or capital outlay. Among these would be various forest products industries (toy manufacture, furniture, cooperage, building materials, wood alcohol), sweet-potato starch, oil extraction (tung, peanut, soybean, cottonseed, castor bean), cotton ginning, quick-freezing, canning, dehydration, milling, dairy products, and pecan processing. This by no means exhausts the possibilities.

Elements of an Industrial Program for the Valley

A plan for industrialization of the Arkansas Valley must rest on certain basic assumptions. They are:

1. That the national income will be maintained in the postwar period at a level of $110,000,000,000 or more;
2. That full employment and full use of material resources will continue in the postwar period;
3. That people and resources will be employed in terms of their optimum productive capacity;
4. That conditions of full consumption will prevail whereby each family will have adequate housing, food, clothing, and other requirements;
5. That the system of private property and free enterprise will not only continue but be enlarged in function and scope.

New Jobs in Manufacturing Industry

The industrial objectives for the Arkansas Valley call for the entrance of an additional 200,000 to 250,000 new workers into the manufacturing industries in the eight states of the region by 1950—over and above the 229,740 engaged in those industries in 1940. (See table 26.) This total was obtained by considering the present amount of manufacturing; the needs of the people; and the specific industrial opportunities of the Valley in terms of its locational advantages, minerals, raw materials, power, fuel, labor, transportation, water, markets, and similar factors.

Areas of Industrial Expansion

By far the greatest portion of the new manufacturing activity will probably come in six industrial areas (as indicated in fig. 12), each of which has been delineated in terms of present industry, resources, labor supply, power and fuel, markets, transportation facilities, and possibilities for industrial expansion. The areas are as follows:

Area 1.—This area is located in southeast Colorado and southwest Kansas. The principal cities are Pueblo, Colorado Springs, Canon City, Trinidad, and La Junta, Colo., and Dodge City and Garden City, Kans. Some 6,000 to 10,000 additional employees could be absorbed here if potential new industry develops.

Area 2.—This area is located in the Texas Panhandle and Amarillo is the important city. Prospective industrial expansion might absorb 6,000 to 8,000 workers.

Area 3.—This area is located in south-central Kansas, central Oklahoma, and north-central Texas. Wichita, Kans., Oklahoma City, Lawton, and Ardmore, Okla., and Wichita Falls, Sherman, and Denison, Tex., are the principal cities in the area. Here 35,000 to 45,000 additional manufacturing employees might be absorbed. It ranks third among the six areas in terms of potential employment expansion.

Area 4.—This area is located in southeast Kansas, eastern Oklahoma, and west-central Arkansas. Important cities in the area are Joplin, Mo., Tulsa, Muskogee, Okmulgee, and McAlester, Okla., Fort Smith, Ark., and a number of cities in Kansas. It ranks second among the six areas in employment expansion capacity, and might absorb 40,000 to 50,000 additional manufacturing employees.

Area 5.—This area embraces portions of southwest and southeast Missouri and northwest and northeast Arkansas. Principal cities are Springfield, Mo., and Batesville, Jonesboro, Fayetteville, and Paragould, Ark. An additional 25,000 to 30,000 manufacturing employees might be absorbed here.

Area 6.—This area is located in southwest Arkansas, northwest Louisiana and northeast Texas. Important cities are Little Rock, Hot Springs, Pine Bluff, Camden, and El Dorado, Ark., Shreveport, Monroe, and Bastrop, La., and Texarkana, Marshall, and Paris, Tex. This, the first-ranking of the six areas, might absorb an additional 55,000 to 65,000 manufacturing employees.

Altogether, these six areas could provide employment for a total of 160,000 to 220,000 more industrial workers. Approximately 40,000 workers might find employment in the remaining sections of the Valley in the post-war decade.

Proposed Industrial Expansion

The annual income of the Arkansas Valley was $2,500,000,000 or $344 per person in 1940. In the next 10 years if the workers are more fully and efficiently employed in agriculture, services, and manufacturing industry the income should rise to $4,700,000,000 for the region. This would assume that with the increased use

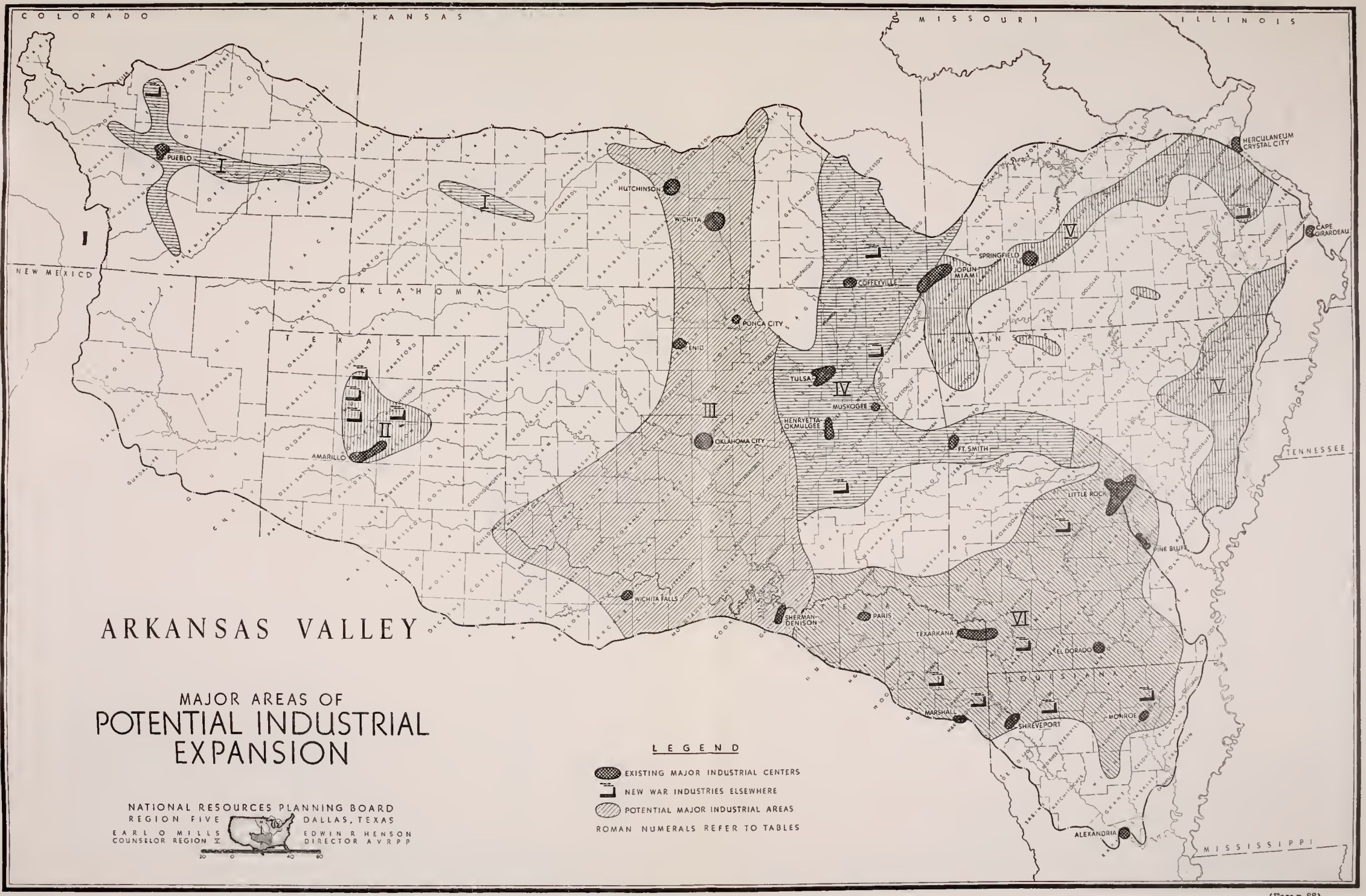

FIGURE 12.

(Face p. 88)

of labor and national resources the people of the area could raise their per capita income to the average for the Nation. The development as outlined in this plan would raise the income of the Valley slightly above the average for the Nation.

The greatly expanded income will bring out local demands for additional goods and services which are to be supplied in part by the expanded manufacturing and service industry.

Foods and Kindred Products

The people of the Valley have very great unfilled needs for food. The food requirements are shown on page 28. The increase in earnings will stimulate this demand for food which, for the most part, will be produced in the Valley.

In the industrial plan an expansion of manufacture of food products for this local demand is contemplated. Products manufactured by such industries would include baked goods, soft drinks, dairy foods, meat products and meat compounds.

Considerable expansion in many other food manufacturing lines is economically justifiable on the basis of available raw materials, labor supply, and potential market possibilities. The planned changes in agriculture will bring a considerably larger production of certain foods such as beans, spinach, tomatoes, cucumbers, corn, peaches, meat, and dairy and poultry products.

The expansion of food manufacturing in the Valley will be greatest in areas of maximum population concentration. A secondary factor determining areas of expansion will be the availability of raw materials locally. Generally these two important locational factors exist side by side. Therefore the major expansion will probably occur in areas 6, 5, 4, and 3.

Textile Mill Products, Apparel, and Leather Goods

Increased manufacture of clothing products is required to supply the local people with needed goods. Figured on the basis of pre-war budgets at various income levels, the increase in earnings of the people would enable them to make additional purchases valued at $160,000,000 or more annually in wearing apparel.

The economic feasibility of expansion in these lines is indicated by the fact that manufacturing profits in the Southwest in this industry were about 50 percent above the national average, according to recent income tax returns. Moreover, there will be an abundant semi-trained labor supply. It is estimated that more than 200,000 women will be employed in all manufacturing industries in the Valley at the peak of war production; many of these will be available for the textile, apparel, and leather industries.

As in the case of food, the expansion of manufacturing in these lines will take place in the most thickly populated areas. Likewise, other factors determining the extent of expansion in various areas will be the availability of raw materials and status of alternate employment opportunities. Areas in which coexistence of these factors make it likely that the greatest employment increase in these industries will occur are areas 5, 6, 3, and 4.

Furniture, Lumber Products, and Paper Products

The increase in the income of the Arkansas Valley resulting from the industrial program will probably create an annual market of more than $200,000,000 for furniture and household equipment. Abundant forest resources and unused lands suitable for the production of timber in the eastern half of the Valley, coupled with the fact that the rate of growth of timber in the area is much above the national average, point to the ability of the Valley to produce the necessary raw materials for furniture, lumber products, and paper industries under favorable cost conditions. Water resources in the forest areas are abundant and of good quality. Water transportation is available in area 6, where the major forest resources are located. Furthermore, the Valley has the advantage of already containing existing centers producing furniture.

The principal expansion in employment opportunities in furniture manufacturing will come in areas 4, 5, and 6, around the existing production centers of Fort Smith and Little Rock, in Arkansas; and Springfield, Mo. Almost all of the expansion in plywoods, paper, and paper products probably will come in area 6, due to proximity of raw materials and the abundance of water supplies.

Stone, Clay, and Glass Products

It would be difficult if not impossible to find an area in the United States better adapted to the manufacture of stone, clay, and glass products than is the Arkansas Valley. Glass sand deposits in northern Arkansas are unlimited for practical purposes and are equal in quality to the best deposits of the Nation. Deposits here average about 99.38 percent silica and contain only unimportant quantities of iron, lime, magnesia, and alumina. Mechanical analyses indicate that over 50 percent of the sand is retained on 65- to 100-mesh sieves. Brick and tile clays of high quality are found in abundance in the eastern part of the Valley, particularly in area 6. Pottery and tableware manufactured in the northern part of area 6 are of especially high quality.

The combination of superior clay and sand deposits, and an abundance of inexpensive fuels, provides the ingredients for a sound expansion in the manufacture of these products if markets are available. The increase in annual expenditures for homes in the Arkansas Valley, and for factory, public, and com-

of labor and national resources the people of the area could raise their per capita income to the average for the Nation. The development as outlined in this plan would raise the income of the Valley slightly above the average for the Nation.

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The combination of superior clay and sand deposits, and an abundance of inexpensive fuels, provides the ingredients for a sound expansion in the manufacture of these products if markets are available. The increase in annual expenditures for homes in the Arkansas Valley, and for factory, public, and com-

mercial buildings, will call for greatly enlarged manufacture of stone, clay, and glass products used in construction.

Technological developments are rapidly widening the markets for glass products. Spun glass, fiber glass, glass building blocks, and pliable plate glass are some of the new products for which rapid increases in production can be expected. The Valley is far from satisfying the present demand for such articles; in a recent year, over 70,000 tons of glass products were shipped into the area. The major expansion in work opportunities in the glass industry will occur in area 4, due to the availability of raw materials and low-cost fuels. Expansion in the manufacture of clay and cement products will be greatest in areas 6 and 5.

Iron and Steel Products, Machinery, and Transportation Equipment

This category consists largely of electrical machinery, appliances, and supplies and equipment, including telephone equipment. Manufacture of these products is rapidly growing on a national scale and it is probable that the anticipated expansion in Valley markets will justify the establishment of new producers.

The proposed installation of more than 1,300,000 kilowatts of hydroelectric capacity alone would demand a large quantity of electrical equipment and supplies, some of which might be made locally.

The housing program called for in the Arkansas Valley plan will create a market of great magnitude for plumbing materials and building materials and equipment. Increased mechanization of agriculture, accompanying the enlargement of farm units, will considerably increase the markets for tractors and other farm implements made from iron and steel.

These factors, indicating as they do an enlarged demand for iron and steel products in the Arkansas Valley, would support continued high operation of the steel plants at Pueblo and in Texas. Any additional necessary raw materials can be brought into area 6 by the water transportation facilities of the Ohio, Mississippi, and Ouachita Rivers at lower costs than finished steel products could be brought into the region by the usual transportation channels.

Nonferrous Metals and Their Products

The reduction in the cost of producing aluminum during the war, and competition from magnesium, stainless steel, and plywood, may result in postwar prices for aluminum low enough to induce a high degree of processing of such aluminum products as fishing and pleasure boats, kitchen utensils, and so forth.

Raw materials and power resources needed for such an industry are available in area 6. Some expansion in zinc and lead processing, and in production of goods from these metals, may come in area 4.

Chemicals, Plastics, and Allied Products

It is anticipated that for several reasons this group of industries may provide more new jobs in the Arkansas Valley than any other major classification.

The chemical and plastics industries can expect much above the average rates of growth on a national scale, according to most industrial experts. The area possesses outstanding advantages with respect to the three most important locational factors: (1) unlimited raw materials, (2) abundant water supplies, (3) adequate low-cost fuel and power resources.

In the Valley's rapidly growing forests, tremendous cotton production, exceptionally large coal resources, abundant petroleum and natural gas reserves, adequate supplies of salt and sulphur, there exists a most satisfactory situation with respect to raw materials. It would be difficult to find a more adequate combination of water, fuel, and power potentialities elsewhere in the United States.

In addition, the Valley is located in the center of a virgin market distant from centers where many products in this group are currently being manufactured.

Appreciable expansion of facilities for producing synthetic rubber and high octane gasoline are occurring in areas 2, 3, 4, and 6. Production of nylon and plastics made from coal tar products will have special advantages in area 4 due to extensive coal and water resources. Potential cellulose resources in the form of rapidly growing forests and a large annual cotton production point to expanded production of rayon and plastics from cellulose in area 6.

Mining, Construction, and Service Industries

Commensurate with increased manufacturing should be the development of mining, construction, and the service industries. An examination of the moderately industrialized States reveals that the employment ratio between manufacturing and these industries is 1 to 3½. While the ratio at present in the Arkansas Valley is higher than this, it will decline as the Valley is industrialized.

Accordingly, it seems feasible to assume that expansion in these fields will be roughly three and one-half times as great as that in manufacturing. On this basis, an increase of 230,000 jobs in manufacturing would create approximately 800,000 new jobs in these industries: 15,000 in mining; 130,000 in construction; 165,000 in wholesale and retail trades; 150,000 in transportation, communication, and other public utilities; 35,000 in finance, insurance, and real estate; 28,000 in business and repair services; 85,000 in personal serv-

ices; 25,000 in amusement, recreation, and related services; 100,000 in professional and related services; 50,000 in government service; and 30,000 in miscellaneous services. (See table 27.)

Conversion of War Industries

The success of the industrial program proposed for the Arkansas Valley depends in a very large part either upon maintaining the present war production plants in operation after the war, or upon converting them to the production of peacetime commodities. On the basis of present information, 200,000 to 250,000 people will be working in these war plants when full operation is attained.

Many war production plants in the Valley can be operated after the war, for the products involved may be used in peacetime as well as during war. Two groups of plants, however, will require conversion, probably with much additional plant and equipment, before they can fit into the postwar picture. These are ammunition loading factories and powder and explosives plants, employing 60,000 to 80,000 workers.

Ammunition loading plants might be converted to the production of small machines, equipment, tools, clocks, kitchen ware, novelty goods, stamped and pressed goods, precision instruments, motors, and other products, but conversion would be both costly and time-consuming. Retooling, additional machinery, and perhaps some different types of labor skills will be required. In no case will conversion be accomplished quickly and inexpensively.

Powder and TNT plants might in part be converted to the production of chemicals of various sorts, plastics, synthetics, and perhaps other commodities. Again, however, a very considerable, and perhaps prohibitively large, investment in time and money would be required to retool, to adapt machinery or bring in new machinery, to make plant additions and to find or train skilled workers.

While considerable expense would also be involved in the conversion of ammonia plants, these plants could produce chemical fertilizers which are in demand in the Valley. It may well be that some of these plants will be needed to satisfy the peacetime ammonia requirements.

The fact that some war industries will continue to operate as such after the war will simplify the problem of plant conversion to a certain extent. It is likely, of course, that one shift will be employed instead of the two or three shifts required during wartime. Personnel thus released might obtain employment in new or expanded factories producing civilian goods.

The remaining war plants present a different and perhaps somewhat less involved type of problem, since their operation will depend on continued demand for a product quite similar to the present military output. Aircraft frame and assembly plants are conspicuous examples of this problem. Their future would appear to depend mostly on the future demand for passenger and cargo planes, and to some extent on military demands for a peacetime air fleet.

Although aluminum has become a basic material for aircraft production, as things now stand, the Valley's aluminum facilities do not make finished products. There are, to be sure, facilities for processing the aluminum ore to the ingot stage, but there are no large rolling or fabricating facilities, and the aluminum ingot must therefore continue to be shipped outside the area for processing and then shipped back into the Valley at considerable expense for war production uses.

The aviation gasoline plants will be needed as the air transport and passenger service is expanded in the postwar period. Moreover, automobiles will probably require higher-octane gasoline.

The butadiene plants may continue operating after the war to produce rubber.

After the war, army depots could be used as storage houses or warehouses for many commodities—including the military goods and supplies stored there now—or as plant space for the production of the many items contemplated in the industrial program for the Arkansas Valley.

The helium plants will be needed after the war and probably will continue production without any cessation.

Lead concentrates probably will be in greater demand after the war than now and the one plant in the Valley will continue production in time of peace.

The pig iron, steel, and coke plants may operate at full capacity after the war to provide this region with all of the homes, household furnishings and equipment, machinery, tools, community facilities, bridges, office buildings, and so forth, that it is expected to need. Because of proximity to home markets, competition from other centers may be less important.

Potassium perchlorate production is so small as to present little trouble. The two zinc refineries will probably be needed as much after the war as at present to produce the zinc required by the proposed industrial expansion in the Valley.

As has been indicated, the most formidable problems of plant conversion will arise in connection with shell loading, powder, explosives, and perhaps ammonia. However, plants manufacturing these products can be converted to the production of a number of civilian commodities, although considerable time and expense will be involved.

To aid in the cost of conversion, the government could make funds available at low interest rates, either by direct loan or by guaranteeing loans. It could also

permit companies concerned to deduct conversion costs from corporate income taxes, or to amortize such costs in 5 years, the period now allowed for amortization of costs of new war production facilities. Another possibility would be outright payment by the government of a portion of conversion costs, the carrying out of conversion as a public works program.

The basic requirement in this field is the formulation now of plans which can be placed in operation as soon as the war is over to convert war industries to peacetime use.

What Industrial Development Will Bring

Among the many far-reaching effects which application of the industrial plan will have, the following are worthy of special note.

Capital Investment

An examination of capital investment for the Nation as a whole indicates that $5,000 per worker is the approximate average for all manufacturing industries. A like study produces a figure of $2,500 per worker for the service and related fields. Using these as the bases for determining the capital investments required to accomplish the industrial part of the plan, the results are as follows:

(a) A capital investment of $5,000 for each of the 230,000 new workers in manufacturing totals $1,150,000,000.

(b) A capital investment of $2,500 for each of the 800,000 new workers in services and related fields totals $2,000,000,000.

Thus a total capital investment of $3,150,000,000 may be required to provide 1,030,000 new jobs in manufacturing and related fields.

Annual Income

Assuming that, on an average, each industrial worker is paid an annual wage of $1,200, the amount necessary to give each family a minimum standard of living, the total annual wage increment in the Valley should be between $1,200,000,000 and $1,360,000,000. The actual wage increment may be either less or more than this figure, because most of the workers had some income before the industrial program started and also because many will receive more than the minimum $1,200 after the program is under way, and because actual increases in production may deviate widely from the goals set in this program.

An examination of the Biennial Census of Manufacturers shows that, for the Nation as a whole, the value of manufactured products is roughly 2½ times the wage bill. Assuming that the added wage bill in manufacturing is $276,660,000 (230,550×$1,200), the value of new manufactured products will be $690,150,000.

An examination of the distribution of the national income among the various factors of production shows that labor receives approximately 65 percent of the total. Assuming on this basis that 65 percent of the added income, $968,400,000 (807,000×$1,200), produced by the service and related fields goes to labor, the total added income occasioned by the expansion of the service and related fields is approximately $1,490,000,000.

Therefore, the total annual increment to Valley income associated with an expansion of 1,037,550 new jobs in manufacturing and related fields, is $2,180,150,000.

Summary

The industrial part of the plan would require the addition of the following to the present economy of the Valley:

(a) 1,000,000 to 1,050,000 new jobs.
(b) $2,180,150,000 in increased annual income.
(c) $3,150,000,000 in increased invested capital.
(d) 11,000,000,000 kw.-hr. annual electrical energy.

This is a plan or framework for the development of the resources of the Arkansas Valley. It is not a State plan. It seeks the full employment of the people and a full use of the natural resources irrespective of where they may be located within the Valley. It relies on a vigorous expansion of private industry to use the labor and the resources in efficient profitable ventures.

Restraints on the small and large business enterprises, whether they be imposed by business organizations through monopolies, control of patented processes, ownership of reserves of raw materials, mechanisms of financing, or are imposed by the public itself through law, will be challenged by an aroused public in the interest of a development of the Valley.

TABLE 26.—*Industrial goals obtainable within 10 years in States or parts of States included in the Arkansas Valley*

[New industrial employment]

Kind of industry	Arkansas	Kansas	Louisiana	Missouri	New Mexico	Oklahoma	Texas	Total [1]
Food and kindred products	6,000	2,500	3,500	4,500	300	4,500	4,000	27,100
Textile mill products	2,800	400	1,000	2,500	25	3,000	1,200	10,975
Apparel and other fabricated textile products	6,100	1,000	1,500	5,000	100	4,000	2,200	20,000
Sawmills, planing mills, logging	1,600							1,600
Furniture, store fixtures, and miscellaneous wooden goods	4,100	500	1,700	3,500	100	2,000	800	12,850
Paper and allied products	2,700	100	2,500	200		500	200	6,225
Printing, publishing, and allied products	600	500	700	1,000	150	1,000	800	5,100
Chemicals and allied products	10,100	2,500	5,000	3,500	100	12,000	5,000	39,100
Petroleum and coal products	200	500	900	200	50	1,000	1,000	4,225
Leather and leather products	700	700	500	5,000	50	1,500	500	9,025
Stone, clay, and glass products	4,800	2,500	1,500	2,500	100	2,500	1,500	15,600
Iron and steel and their products	2,200	1,500	1,300	2,000	50	2,200	2,000	13,950
Nonferrous metals and their products	1,600	500	300	1,000	75	2,000	500	6,425
Machinery	2,300	1,000	1,000	1,000	75	3,000	1,000	9,850
Automobiles and equipment	600	200	300	200		200	300	1,850
Transportation equipment		3,000	100	700	25	2,300	300	6,175
Other and not specified manufacturing industries	10,500	3,100	6,200	3,700	200	11,300	3,400	39,900
Total	56,900	20,500	28,000	36,500	1,400	53,000	24,700	230,550

[1] Includes entire drainage basin of Arkansas and Red Rivers.

TABLE 27.—*Employment goals in related fields commensurate with industrial development in the next 10 years*

[New employment]

Kind of industry	Arkansas	Kansas	Louisiana	Missouri	New Mexico	Oklahoma	Texas	Total [1]
Mining	4,000	1,500	500	500	200	5,000	2,000	15,200
Construction	33,000	12,000	15,000	20,000	600	30,000	14,000	128,600
Transportation, communication and other public utilities	35,000	13,000	17,500	23,500	900	30,000	15,000	141,900
Wholesale and retail trade	39,000	13,000	20,000	27,000	800	40,000	19,000	164,800
Finance, insurance and real estate	9,000	3,000	3,500	6,000	200	8,000	3,000	34,200
Business and repair services	6,000	2,500	3,500	5,000	200	7,000	3,000	28,200
Personal services	23,000	8,000	11,000	13,000	500	20,000	9,000	87,500
Amusement, recreation and related services	5,000	2,000	4,000	3,000	200	7,000	2,000	24,200
Professional and related services	26,000	10,000	13,000	18,000	700	20,000	10,000	102,700
Government	12,000	5,000	4,000	9,000	300	12,000	5,000	49,300
Industry not reported	7,000	2,000	6,000	3,000	400	7,000	4,000	30,400
Total	199,000	72,000	98,000	128,000	5,000	186,000	86,000	807,000

Includes entire drainage basin of Arkansas and Red Rivers.

TRANSPORTATION

As may be expected in an area as large as the Arkansas Valley, the various transportation facilities form a rather complex system with many points of contact, much duplication, some unnecessary links, and numerous missing portions. Some thought must be given to more effective distribution, location, and coordination of the existing agencies of transportation if they are to serve the best interests of the public in rendering all types of transportation adequate and economical. It may also be well to attempt to bring about greater harmony among the several transportation agencies in order that hostilities may be eliminated and greater cooperation among them promoted.

Railroads

The Valley is served by a fairly close network of railroads, including at least 15 principal systems. In the past 20 or 30 years, the railroad map of the Valley has changed only slightly, and abandonment of railroad mileage has been greater than the amount of new construction. Many branch lines originally built to tap lumbering or mining projects have outlived their usefulness; traffic on other branch lines has gone to motor carriers and private automobiles, and these lines have been abandoned.

However, under normal conditions of highway transportation there are too many miles of railroad within the Valley. In fact, the region has not only mileage and service adequate to care for that form of transportation for many more years under the present agricultural and raw material economy, but also to serve a greatly increased industrialization except for necessary additions of interconnections, some double tracking, and improvement in road beds, motive power, and rolling stock. Moreover, the present railroads serve sections of the Valley where industrialization will most likely occur.

Problems

The complex problems of railroads in this area are similar to those of the entire Southwest and West. In large measure, the main lines were thrown into unsettled areas in a scramble to preempt potential producing territory and to gain entrance into all growing centers of population. These developments were aided and stimulated by a liberal land-grant policy and by the financial assistance extended by States and localities. To provide traffic for main routes in sparsely-settled country, branches and feeder lines were constructed in every direction. Combinations of some of these

eventually produced new competitive through routes between important cities; many of these routes were quite circuitous as compared with the most available direct line.

Economic guiding principles were nowhere applied in the course of these developments. Instead, the crying need for transportation in a pioneer area, the overenthusiastic ambitions of promoters and land speculators, and the inducements offered by governments, very largely controlled not only the quantity but the distribution of railroad facilities. The system was not consciously planned to meet these needs economically.

The Valley lies in a broad territory that embraces one of the most sharply competitive sections of the railroad network. Historically this factor has had considerable effect on the development of the rate structure and services offered by the carrier. This results in wasteful duplication both of facilities and services, producing effects which are undoubtedly detrimental to the area. Railroad costs are increased by the maintenance of excessive mileages: standards of track construction, maintenance, grades, and other physical characteristics are lower than they might be were traffic more concentrated; and duplicate schedules result in poorer train loadings.

Until rationalization of the rail system can be effected, the region will, on this account, continue to carry a considerable burden. It must be remembered, however, that to carry their operations the railroads rely heavily on through business to and from the Gulf, and on their western connections. This essentially overhead business moves through the Valley at the expense of shippers elsewhere and contributes to the maintenance of the properties.

Interterritorial Freight Rates

The expansions of industrial development in the Valley, or continuation of expanded wartime production in the post-war period, would be greatly facilitated by adjustments toward more favorable transportation rates.

As they exist in the United States today, freight-rate structures are products of gradual growth, shaped largely by the predominant economic conditions prevailing within particular territories during the periods of their evolution. No territorial freight-rate structure has been specifically designed for the accommodation of a national commerce, or with a view to promoting uniformly the resources of the Nation. This is true because freight-rate structures are not created overnight or even over a period of a year or so but accumulate as time goes on and as various types of traffic either are offered the railroad or leave the rails for other forms of transportation. As a result, it appears that economic conditions, as well as the technique of transportation, often change faster than the freight-rate structures.

When manufactured articles are moved from the Southwest, or any other outlying territory, to markets in the northern or northeastern part of the country, competition must generally be met from manufacturers of similar products located in the Northeast who in many instances can reach the same consuming points on intraterritorial freight rates that are lower, mile for mile, than the interterritorial rates which outside manufacturers are compelled to pay. Frequently the reverse of this is not true. There is therefore an adverse situation with respect to some manufacturers in the Arkansas Valley.

Rail Transport Recommendations

In its broadest aspects, any regional plan for adjustment or improvement of local railroad problems encroaches upon the national railroad problem, which cannot be solved locally. From both the national and regional viewpoints, however, it is desirable to take a position in cooperation with State and Federal authorities in order to:

1. Provide for improved service and effect all possible economies through the consolidation of local lines into unified systems;
2. Eliminate unnecessary duplication of facilities and unify terminal facilities;
3. Coordinate railroad services with motor carriers, airlines, and pipe lines;
4. Construct new lines where they would shorten distances or open new markets, eliminate unnecessary branch lines, and plan for the eventual abandonment of some railroad lines in the region;
5. Work toward the equitable revision of regional and National transportation rates.

Highways

The general framework of principal highways in the Valley makes fast and reasonably safe travel possible throughout most of it, except in the vicinity of the larger cities and through certain closely developed areas.

All parts of the Valley are not, however, either equally or adequately served. There is evidence in some States of an unbalanced distribution which may in part be due to the county bond issue plan. Certain counties are more able to build than others, and they have built roads without regard to the relative needs of the State, certainly without regard to any plan of development for the Valley. Then, too, public pressure on local and regional leaders often brings results that are not in keeping with a well-balanced, efficient, and economical highway system.

The greater number of hard-surface roads is to be found in the central and eastern portions of the Valley. This is partially justified by the greater traffic volume

in this area. Then, too, being able to raise funds more readily, these counties obtain a larger share of Federal "match money."

Generally speaking, there is sufficient mileage, and a sufficiently proper distribution of roads, to serve as the basis for a well-planned highway system in the Valley. However, certain deficiencies stand out; for example, insufficient diagonal highways in Oklahoma; a decided congestion of converging routes at several of the larger cities; a lack of adequate by-pass routes at numerous points where such routes would be advantageous; and many indirect highway routes involving wasted mileage for both pavement and highway users.

Motor Transportation

Bus and motor truck lines occupy a position of great importance in the transportation system of the Valley, but very little reliable information is available on the location, operation, and mileage of the many carriers of this type. Routes change frequently, the industry has been in the process of consolidation, and the number of small operators has been rapidly decreasing. Throughout the Valley there are many specialized carriers, such as lumber and petroleum haulers; small companies are constantly going into or discontinuing operations, and some operate during only part of the year.

In the Valley, as in other parts of the country, a few large bus and truck carriers operate over long routes and secure a large percentage of this type of business; these companies alone have approached a stable operating basis. Much unnecessary overlapping of bus and truck routes will be found, as well as unwarranted duplication of service with that of railways.

Under legislation enacted in 1935, there has developed a gradual tightening of regulation that tends to stabilize and regularize the routes, service, and rates of both common and contract motor carriers.

For the most part, past development of bus and truck transportation has come about without adequate planning and coordination. Since the rapid development of these carriers in the past indicates further development of major importance, there is urgent need for planning. In this connection, it should be borne in mind that the highway system is an important factor in planning the future bus and truck transportation system of the Valley and its coordination with the railroads and airlines.

Interstate Trade Barriers

The Arkansas Valley is one in which interstate trade barriers to the free movement of motor transportation have been particularly objectionable in the recent past. These barriers generally take the forms of varying requirements as to equipment, lighting and safety appliances, sizes and weights, registration and special taxes, port-of-entry regulations, and the like.

Steps might well be taken to bring about a greater degree of uniformity in these matters within the Valley. Such uniformity should be brought about by the cooperative action of the individual States, giving consideration to the commerce of the Valley as a whole, with no distinction made between interstate and intrastate commerce.

Highway Recommendations

1. A long-range comprehensive plan of major Valley highways should be formulated, in cooperation with the State highway authorities concerned, to serve as a guide for the construction and improvement of all through routes in the region.

2. Since some of the counties in the area appear to have more miles of road than they can maintain under their present revenues, steps might well be taken to eliminate from their road systems all sections which are serving essentially as private roads, thus releasing money and equipment for other highway work. In accordance with the plans for agriculture, some of the back-country roads can be eliminated.

3. Counties should prepare long-term plans for highway improvements, and should cooperate with State and Federal authorities in carrying them out. State highway systems should be removed entirely from local control and influence.

4. Additional wayside or roadside parks should be established.

5. Roadside development should be controlled through zoning, easements, or other suitable means.

6. Better access-roads are needed in some sections of the area for mining and lumbering districts.

7. Present State-made barriers of free movement of motor carriers over State lines should be eliminated.

8. Cooperation and coordination between motor carriers and other forms of transportation should be encouraged, as should also the planning of any future expansion of motor transportation.

Airlines

Air transportation depends on airways, airports, and airlines. Two transcontinental airlines, Transcontinental and Western Air, Inc., and American Airlines, Inc., traverse the Valley, which is also served on north-south routes by Braniff Airways, Inc., and, between various points by Chicago and Southern Airlines, Continental Airlines, Mid-Continental Airlines, and Delta Airlines. All these lines of course make use of Federal airways.

Air transportation in the Valley now is of distinctly

local importance, only 17 points receiving commercial airline service at present. These are: Monroe and Shreveport, La.; Wichita Falls and Amarillo, Tex.; Oklahoma City, Tulsa, and Ponca City, Okla.; Little Rock, Ark.; Wichita, Hutchinson, Dodge City, and Garden City, Kans.; La Junta, Pueblo, Colorado Springs, and Trinidad, Colo. The Valley is a part of that area in the United States which is now inadequately served by existing trunk airlines, and where the need for feeder-type airlines serving smaller communities is manifest.

Airports

It is not merely true that there can be no air transportation in any area without airports; it is also true that no airport exists by itself. The usefulness of an individual airport depends on the status of other nearby airports, even those 100 miles or more distant.

Though communities may be rivals in the attractions their respective airports offer to air traffic, their common interest is far more important than their rivalry. Every user of aircraft, every community that has drawn upon its resources for airport construction, and every commercial interest that has a stake in an airport, have the best of reasons to become zealous partisans of the maintenance of a fully adequate airport system serving every part of the region.

Feeder Airlines

Within recent years there has been a good deal of agitation for the development of what have come to be known as feeder airlines, even though this term has lacked specific definition in the type of air transport service contemplated by such carriers. On many occasions since 1938, community representatives and others from points within this Valley have appeared before the Civil Aeronautics Board to testify to the need for feeder airline service to connect their communities with the trunk airlines.

The outstanding characteristic of feeder airlines is the part they will play in the concentration and distribution of goods and services in the areas they serve. Not only will a feeder airline move traffic from one point to another—the principal function of a trunk line—but it will gather mail, express, and passengers from a large number of small scattered trading areas and feed them into a few terminal points.

Special Aspects of Air Transportation

Any study of transportation conditions as they exist in a particular area today must be made with the realization that they are largely historical. Inevitably the war is going to result in a tremendous development of air transport. The end of the first World War brought airplanes of no real commercial value, with no efficiency whatever in load carrying. The present war, however, accenting as it does the transportation by air of war cargoes and of armies, will give us a vast number of really useful aircraft, many of which could go at once into some sort of commercial use.

Passenger travel presents the most favorable field of expansion for air transportation. The inducements of speed, convenience, and comfort combined with progressive lowering of rates are obvious reasons for this. In relation to the Arkansas Valley the growth of air travel especially concerns the development of the Ozark-Ouachita recreational area. It will open the attractions of this mid-continent vacation region to the people of a much wider territory than now served, and a great extension of tourist and recreation facilities may be expected.

Another fertile field for development of air transportation lies in the movement of express. In 1941, air express totaled only 5,500 tons, compared with well over 3,000,000 tons moved by rail. The speed and flexibility of air service are well adapted to this type of freight movement, and it is believed that eventually a large proportion of express commodities will move by air.

In the movement of heavy cargo speed is relatively unimportant and one of the great advantages of air transport is not significant. Although there is much uncertainty concerning the cost of operating the cargo planes of the future it does not appear plausible to anticipate here that this phase of air transportation will affect greatly the immediate developments contemplated in this report. However, the flexibility offered by air transportation, and the resultant shortening of distances, may make it advantageous for certain manufacturers to shift production sites to places where cheaper fuel and power are available, where labor is plentiful, or where climatic conditions are more favorable.

Airway Recommendations

1. Foster the development of a coordinated system of airports throughout the Valley, suitable for all types of air transportation.

2. Encourage the development of feeder airlines to reach smaller communities with air-mail pick-up and delivery services as well as with standard passenger, mail, and cargo services.

3. Provide facilities in the Ozark-Ouachita recreational area designed especially to accommodate vacationists traveling by air.

Waterways

Water transportation is of minor importance in the Valley, with the exception of the Ouachita River from its mouth to Camden, Ark., in which reach a dependable

6-foot navigation has been provided. In addition, intermittent navigation is now possible for boats of shallow draft on the Arkansas River to Pine Bluff, Ark.; on the Red River to Shreveport, La.; on the Ouachita River above Camden to Arkadelphia, Ark.; and on the White River to Guidon, Ark.

For year-round navigation on these rivers a permanently-improved channel has been proposed which will have a 9-foot depth through the construction of locks and dams. Such developments are now being studied and appear to have considerable economic merit. With the industrial expansion planned for the eastern portion of the Valley it may become evident that navigable waterways are essential to the best transportation network for the area.

Waterway Recommendations

1. Cooperation with State and Federal authorities in development of navigation on suitable waterways in the Valley.

2. Insistence upon coordination of waterway and other transportation services as developed.

General Comments

The 15-year period ensuing after the passage of the Transportation Act of 1920 presented a golden opportunity for the integration of all forms of transportation. However, little was done about it. Instead the Nation was presented with a new leverage to enforce the doctrine of competition. In other words, all forms of transportation would now be treated separately, kept in their own spheres, played against each other.

Thereupon followed a decade of the most destructive transportation competition in the country's history. Needless duplication of facilities ensued. Excessive costs and waste throughout the country had their repercussions in the Arkansas Valley in delaying rate reductions and improvements in service. Prior to the unprecedented but transitory demands for all types of facilities from the present war, all agencies of transportation were engaged in a bitter struggle for available traffic.

This development of each agency of transportation carried out by independent bureaus, through unrelated legislative policies, will probably be supplanted in the postwar era by coordinated Federal activity directed toward an over-all transportation objective which has already been stated by the National Resources Planning Board as "the development and preservation of a transportation system representing an optimum combination of economy, speed, safety, and convenience, and designed to further policies of the Federal Government with respect to such factors as resource utilization, industrial location, distribution of population, land-use planning, the diffusion of culture, the maximizing of income, and the National defense."

To bring about such a condition within the Arkansas Valley, any changes in present transportation facilities or in future developments of new facilities should in general be aimed at:

1. Giving the public as a whole the benefit of public expenditures;

2. Treating all forms of transportation impartially, in regard both to equality of regulation and to equality of opportunity;

3. Creating an equitable tax burden;

4. Avoiding unproductive or duplicated capital expenditures.

URBAN DEVELOPMENT

Thirty years ago less than one-fifth of the people in the Arkansas Valley lived in cities, towns, and communities of over 2,500 persons. Now the proportion is one out of every three, and steadily increasing.

Whether that is a desirable or undesirable condition may be questioned, but the fact remains that a rapidly-increasing proportion of the people in the Valley do live and make their living under urban conditions. Hence it is important that such conditions be examined to see whether the cities and villages are in a position to contribute all that they should to the welfare and success of the people who live or will live in them.

Extent of Present Urbanization

At the time of the 1940 Census there were 227 cities, towns, and other communities in the Valley with 2,500 or more inhabitants each. Eight of these are "metropolitan" centers of over 50,000 population each, of which the largest is Oklahoma City, with 221,000 people. There are 8 other cities between 25,000 and 50,000 each, and 40 between 10,000 and 25,000 each.

Two-thirds of the communities have less than 10,000 persons each. Almost one-third of the total urban population in the region lives in places of less than 10,000; while 21 percent reside in cities of from 10,000 to 25,000; 12 percent, in those of 25,000 to 50,000; and 37 percent, in metropolitan areas.

Moreover, these relative proportions have held at a fairly steady level over a period of years, and hence may be expected to continue somewhat similarly in the future, except for the metropolitan group, which has been increasing in population more rapidly than the others.

Unlike many other sections of the country, the

Arkansas Valley has not yet become highly urbanized. Indeed, all the larger cities in the Southwest are located outside this area, many of them just over the borderline in various directions. These include St. Louis and Kansas City, Mo., to the north; Memphis, Tenn., to the east; New Orleans, La., to the southeast; Dallas and Fort Worth, Tex., to the south; and Denver, Colo., to the northwest. These latter cities serve as the primary focal points for business, finance, marketing, manufacturing, and shipping in the south-central part of the country. Moreover, many of the larger war industries are being located in these bordering metropolitan areas, thus furnishing an outlet for much of the Valley's man power and raw materials.

Cities of the Valley

Each of the eight metropolitan centers within the Valley has some particular function and character which may be of interest in connection with its future development. These include:

City:	*Metropolitan population, 1940*
Oklahoma City, Okla	221,229
Tulsa, Okla	188,562
Wichita, Kans	127,308
Little Rock, Ark	126,724
Shreveport, La	112,225
Springfield, Mo	70,514
Pueblo, Colo	62,039
Amarillo, Tex	53,462

Oklahoma City

Typical of many cities in the Arkansas Valley, Oklahoma City is relatively young. It was founded in 1889 at the time the first land in Oklahoma Territory was opened for settlement and has enjoyed a rapid growth ever since. It is now the political and commercial capital of Oklahoma, in which are concentrated the principal agricultural, marketing, transportation, and journalistic interests of the State.

Its growth since the beginning has been predicated largely upon a flourishing agricultural hinterland. State headquarters for grain, broom corn, livestock, cotton, and other agricultural interests are maintained here. The Oklahoma National Stockyards and State Fair are both located in this city. Oil was discovered in the vicinity in 1928 and the resulting business in oil production and oil field supplies carried the city through the depression years of the nineteen-thirties.

Oklahoma City is the principal wholesale and retail market in the State, its trade area extending throughout Oklahoma and into the Texas Panhandle. Its industries are mostly of the local service type, but there is also a considerable amount of activity in meat packing, grain milling, and manufacture of oil field equipment. A good deal of cotton is handled through this point. Large-scale industrial development might be handicapped by the absence of large supplies of water. Since the beginning of the war there has been some development of the aircraft industry.

Tulsa

Tulsa, like Oklahoma City, sprang up after the settlement of the Indian Territory began, or about 1882. In 1901, oil was discovered nearby and the resulting boom of the midcontinent area caused the city to grow at a spectacular rate. It is now the second city in Oklahoma with an economy based primarily upon the exploration, production, refining, transportation, and marketing of oil. Oil field equipment is manufactured here, as well as structural steel, chemicals, and glass. In addition, there is some handling and processing of agricultural products such as cotton and, more recently, aircraft production.

Trade territory is limited to northeast Oklahoma and the purchasing power within that area is rather low. As a "white-collar" oil center, however, the city has a relatively wealthy population with a high standard of living. During the past few years the emphasis on both oil production and refining has been shifting to the Gulf coast. It now seems clear that with oil production on the wane, the city must turn aggressively toward other resources for continued prosperity. Since 1939 Tulsa has grown rapidly and at present has many important war contracts, especially for oil well equipment and housing materials. As Tulsa is in the heart of an area having diverse industrial possibilities its further industrial development is expected.

Wichita

Wichita came into being about 75 years ago as an important cattle market in the central Kansas plains. Its location was determined largely by the railroad terminus of the old Chisholm cattle trail from Texas and Oklahoma. It has enjoyed a steady growth and is now a center of the milling, meat packing, oil, aircraft, and broom corn industries.

It is the fourth largest grain-milling center in the United States, and ranks sixth in the Nation as an interior grain market. Retail and wholesale distribution and warehousing are quite important. Livestock also plays an important part in the economic life of this city, which has large stockyards, packing plants, and horse and mule markets.

Wichita was one of the first cities in the United States to manufacture airplanes on a commercial basis and this is now the leading industry. All local airplane plants are at present engaged in war production. The city has also become an important oil-business and refining center, and a market for farm and road machinery. Food, dairy, and petroleum products,

brooms, fertilizers, flour, farm equipment, tile, steel and foundry products, clothing, and a variety of other commodities, are manufactured here.

Little Rock

Little Rock is the oldest of the large cities in the Arkansas Valley, having been founded over 120 years ago. It was established at the point where overland trade routes crossed the Arkansas River and grew up along with the resulting steamboat traffic. It is now the capital city as well as principal business and financial center of Arkansas, containing one-third of the total urban population of the State. One-fourth of its population is Negro.

The economic base of Little Rock rests largely upon nearby agricultural and forest products such as cotton, corn, feed, and vegetables. Important activities include transportation, warehousing, wholesale and retail trades, and State government activities. There is some manufacturing of clothing, textiles, and other cotton products, clay and timber products, fertilizers, and the like. Large railroad shops furnish considerable employment. In the last year or so several large wartime plants have been constructed nearby to produce aluminum, chemicals, and explosives.

Shreveport

Shreveport is also one of the older cities in the Valley, having been founded about 1835 as a Red River trading post to distribute supplies into the Republic of Texas, Old Mexico, and the Indian Territory. It has enjoyed rapid growth and is now the second largest city in Louisiana. Thirty-five percent of its population is Negro.

Its present economy relies mainly upon agriculture and oil. It is the principal shipping, distributing, and banking center for the agricultural and oil territory of northwest Louisiana, east Texas, and southwest Arkansas. Industries are based on the processing and shipping of timber, petroleum, cotton, and grain and feed crops, and include oil and lumber products, window glass, fertilizers, cotton products, chemicals, paper, oil-well equipment and supplies, and foundry, feed, grain, and food products.

Springfield

Springfield has long been the established marketing and transportation center for the Ozark plateau region in southwest Missouri. It contains important railroad shops and offices. Shipping facilities for the surrounding farm region are located here. It is the center of an important fruit, poultry, and dairying industry that ships fresh milk as far as Boston and is said to be the largest primary poultry market in the world.

Its growth has been steady but its industrial development has not been outstanding. There are some meat packing, cheese making, wood working, and milling industries, as well as marble and lime works. This is an important hospital and educational center for southern Missouri.

Amarillo

This city, like those of Oklahoma, came into existence about 50 or 60 years ago and has grown up at a phenomenal pace along with the surrounding country. Amarillo is the principal retail, wholesale, and shipping center for the southern High Plains, which is a thriving oil, gas, cattle, and wheat section.

Its industries include grain elevators and mills, oil refineries, railroad shops, packing plants, steel fabrication shops, food and feed plants. Recent wartime developments include helium, zinc, and synthetic rubber plants in the nearby vicinity.

Other Communities

There are several important groups of mining communities within the Valley as well as oil field towns. The tri-State lead and zinc district of Missouri, Kansas, and Oklahoma, has produced such communities as Joplin, Mo., Galena, Kans., and Picher, Okla. Similarly the St. Joe lead district near St. Louis has developed Bonne Terre and Flat River, Mo. Along the upper Arkansas River in the Colorado Rockies there are several mining communities such as Leadville and Salida. The coal fields of eastern Kansas and Oklahoma include Pittsburg, McAlester, and Hartshorne, while the southeast Colorado coal fields are served by such towns as Walsenberg and Trinidad.

Most of these and other mining towns are characterized by a rather fixed population which fluctuates up and down with the demands for their mineral products. Somewhat different, however, are the oil field towns such as Seminole, Borger, Pampa, Cushing, Drumwright, and Burkburnett. This type of community usually springs up suddenly with the discovery of oil and booms tremendously for a few years, until the oil play is over and the field settles down to routine production. As the oil has become exhausted, many oil towns have eventually passed almost completely out of the picture or have remained merely as "ghost" towns.

There are only a few industrial cities within the Valley whose chief source of livelihood is manufacturing. Among these might be mentioned such towns as Ponca City and Bartlesville, which are refining centers, Henryetta and Sand Springs, which are small, heavy industrial centers, and Pueblo, Colo., which is an iron smelter and steel mill city.

The Valley contains a number of health and recreation resorts, most of which are in the Ozark and

Rocky Mountains. Hot Springs, Ark., and Sulphur, Okla., both adjoin national parks where thermal or medicinal waters are found. Eureka Springs, Ark., and Branson and Neosho, Mo., are resort communities in the Ozark area. Colorado Springs, Colo., is one of the principal tourist resorts in the Nation. These towns have enjoyed a fairly consistent if unspectacular growth over a period of years, which may be increased somewhat if greater emphasis is placed upon the recreational opportunities in the Valley.

Throughout the commercial timber country of Missouri, Arkansas, Louisiana, and eastern Oklahoma, there are many small saw-mill and wood-products communities of which Mena, Ark., Ruston, La., and Idabel and Poteau, Okla., are typical. These towns usually flourish until the nearby timber is exhausted, and then slowly decline. Another group of communities which includes Norman and Stillwater, Okla. and Fayetteville, Ark., may be classified as educational or institutional centers dominated by major universities or colleges, or large institutions.

Virtually all the remaining communities in the Valley are typical trading and shipping points for the surrounding countryside, and their growth and prosperity have been determined pretty largely by the character of nearby rural activities. They handle and ship farm and ranch products, supply the needs of farm people, and serve as local administrative centers.

Where the rural population is dense as in central and eastern Oklahoma, southern Arkansas, northeast Texas, and northern Louisiana, the communities are close together. Due to a combination of through transportation routes, dense rural population, and extensive oilfield development throughout central and eastern Oklahoma and eastern Kansas, over half of the urban population of the Valley lives in a belt of cities and towns 150 to 200 miles wide extending down through this section.

In the western ranching country and the eastern timber belt only a limited number of towns has developed. The growth of individual towns in this group has varied considerably according to the stability of the rural surroundings. Where agriculture is sound, as in the winter-wheat section of north-central Oklahoma and southern Kansas, the communities have had a sure, steady growth.

Problems of Communities

In the large view, the problems of cities in the Arkansas Valley are the problems of cities throughout the United States. The first compelling consideration concerns the changes due to the war and the forces set in motion as a result of the war.

During the war, cities face increasing difficulties. On the one hand, many of them have to provide new facilities in housing, transportation, and utilities; on the other, existing equipment and facilities are being worn out.

Cities are expected to enlarge or maintain services in the face of curtailed or declining revenues and loss of manpower. They have had no plans prepared for meeting war emergencies and are forced to meet changes in piecemeal fashion. They have no statement of specifications that shows where and how they fit into the over-all national program.

Aftermath of the War

Changes and forces set in motion by the war will bear directly on post-war urban development; it cannot be expected that cities will revert to the pre-war *status quo*, either as to actual conditions or as to directions of development.

The first phase of post-war effort will be tied to demobilization, during the period when men must be returned to manufacturing, farming, commerce, mining, the service trades, and their homes. If the war lasts long, there will undoubtedly be strong pressure when peace is declared to make a sharp break with wartime controls, to stop all war production, and to release men immediately from the armed forces.

Unless plans are prepared now, by and with the cities as well as on other fronts, to be ready for "demobilization" day, it will not be possible to meet this pressure intelligently and head off disorder. The cities did not have plans to meet the war; they must have plans to meet the peace.[1]

Contributions to construction, particularly the expansion of prefabrication in the production of housing, may help make possible long-desired changes in urban housing. Revolutionary air transport may reduce urban concentration, call for smaller and spread-out cities. Prefabricated housing may become a major factor in slum clearance.

It is not necessary to go through the entire list of changes that may take place to see quickly and clearly that future patterns of cities are dependent in great measure on what comes out of the war.

Outside Relationships

As pointed out heretofore, these problems facing cities in the Valley are the problems that face cities throughout the country. The same questions can be asked concerning them: What is the future economic role of this city? What industries will give employment? What balance of specialization and diversification will make for urban stability? What services will the city be called on to provide? What place will the

[1] For a list of specific social objectives for urban planning by Mr. Frederick M. Babcock, Vice President of the Allied Building Credits, Inc., see, *Architectural Forum*, December 1942, p. 94.

city have in relation to the economy of its region? What do we have to do to meet changes due to the war and how shall we go about meeting them?

But there are in addition certain problems individual to the communities of the Valley. To a great extent the future of the cities within the Valley will be affected by future relationships between them and cities bordering the area.

There will need to be some study of how much the cities of the Valley are subsidiary to these neighboring metropolises, how much they are likely to be subsidiary in the future. There will need to be some analysis of the services now supplied by these outside cities to determine which should be dispersed throughout the region, and which should continue to be centralized. There will need to be consideration of similar displacements of industrial activities in the movement of industries between these cities and the Valley, and in the establishment of new industries.

Cities in the Valley are comparatively young but some of the unhealthy conditions of older cities have been allowed to develop. These must be removed, possibly through city redevelopment agencies given powers analogous to those of housing authorities. Perhaps the housing authority, where it exists, can be remodeled into a redevelopment authority and thus provide a sounder base for slum clearance and rehousing.

Healthy development consistent with the regional characteristics and possibilities may be suggested in patterns of housing and circulation designed in the spirit of the open country of this region. Urban congestion should be prevented as well as cleared. The new forms of motor and air transport should be anticipated and physical patterns of cities should be designed to meet the needs of these forms in expansion of commercial and passenger airports and military and training fields, and in the consolidation of old and the location of new terminals.

These general directions for planning will, of course, need specification. The people of the Valley, and those State and Federal agencies assisting them, should begin now to specify what they want and what they can work out in terms of the regional character, resources and development.

New Communities

A special urban problem likely to develop in this region is the need for new rural communities which may result as the plan for regional agriculture is developed, and as rural industry is introduced. Increased mechanization of agriculture and the possibilities of farm worker commutation may call for the design of new rural communities.

Temporary Communities

There is also in the region the problem of temporary communities to meet conditions imposed by extractive industries—mining, oil, and lumbering. Together with the design and planning of such temporary communities, there should be a parallel program of resettlement and the orderly and economic liquidation of communities of this kind which it is no longer desirable to maintain.

Summary

In the making of this plan or framework for the development of the Arkansas Valley no specific studies of the possibilities or place of individual communities have been attempted. Many urban communities face the complicating problems of expansion; others, problems of maintenance, as they depend upon increasing or decreasing basic resources. Opportunities for work will be a prime requisite of the thriving community in a nation committed to the full employment of the people. Satisfactory living conditions, services, recreational and medical facilities and educational opportunities may weigh more heavily with the worker in the future in the selection of a place to live.

COOPERATIVES

In the past the Arkansas Valley has depended primarily on the usual business incentives for industrialization. To date this has not been adequate. In the main, the resources either have not been developed or have been extracted and sent out of the area in raw or semifinished form. Employment has been insufficient, and basic needs for consumer goods have not been met.

The cooperative movement, along with individual and corporate industrial organizations, can be of much value in developing industries to use more fully the resources of the Valley. Operating as they do on the basic principles of open membership, democratic control, neutrality in political and religious issues, limited investment, continual expansion, and continual education, cooperatives provide a broad framework for the functioning of economic democracy.

The ability of cooperatives to meet the needs of the people of the Valley has already been demonstrated by the amazing progress of rural electrification and numerous other cooperative servicing, marketing, and purchasing organizations.

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In the critical conflict between the technical need for large commercial and industrial organization, and the social need for democratic control and concern for consumer interests, cooperatives have a definite place. On a national and international scale cooperatives have proved themselves capable of effective organization. Grown to greater size and strength, cooperatives can provide a democratic service-based method of economic organization to supply the needs of people while conserving and protecting the future interests of the community.

Present Cooperative Developments

A sizeable number and variety of cooperatives are now established in the Valley most of which are either producer or marketing cooperatives.

The Valley is served by two cooperative wholesale houses, one at Amarillo, Tex. (with a branch at Dallas) and the other at North Kansas City, Mo. However, no wholesale cooperatives operate in the southeast portion of the area.

The most extensive cooperatives in the Valley are the rural electrification cooperatives. In 1934 fewer than 5 percent of the farm homes were electrified; now 23 percent enjoy the benefits of electricity. Membership in these community cooperatives totals 148,000.

Then there are approximately 550 cooperative cotton gins in the Valley, about 80 consumer goods cooperatives, many credit unions, numerous farm machinery cooperatives, and a strong rice growers' cooperative, as well as cooperative purchasing associations and health groups organized throughout the Valley for low-income farmers.

Prospects for Cooperatives

While cooperatives are far from being the dominant type of economic enterprise in the Valley, their continuance at the present rate of growth will soon have a wholesome influence on costs of production and distribution. The rural electrification cooperatives have reduced costs as well as extended services in their field. However, 500,000 homes in the area yet remain without electricity and at least 75 percent of these should be electrified as soon as practicable. Small and large cooperatives can be established to carry out this work.

Experiments are being conducted in cooperative land ownership and management, which may prove a solution to the problem of securing to individual members the benefits of large-scale, mechanized, and specialized farm production.

While cooperative ventures have sometimes failed in the Valley, due largely to lack of education in the aims and operation of such organizations, progress among well-organized, well-managed cooperatives has been rapid. Capital assets of one consumer group serving the Valley in part have grown from $3,000 to $700,000 in 11 years. Business during 1941 grossed $10,000,000; during the first 6 months of 1941, business was 65 percent ahead of that for the same period last year.

Through the Texas Federation of Cooperatives, recently formed among the 850 cooperatives of Texas education for cooperatives should progress more rapidly than heretofore, particularly if the Federation grows as it should beyond State lines, perhaps ultimately embracing the entire Southwest.

All States in the Arkansas Valley have enacted legislation authorizing the organization of agricultural marketing cooperatives generally empowered to engage in any activity in connection with the processing and marketing of agricultural products, and in furnishing machinery and supplies to members. Legislation granting cooperatives broad powers to engage in miscellaneous commercial and manufacturing activities not directly related to the marketing of agricultural products has been enacted in Arkansas, Kansas, Missouri, and New Mexico. Only in Arkansas and Louisiana have marketing cooperatives been granted specific power to furnish members with medical and dental care, hospitalization, and related services.

Cooperative enabling legislation in the States where it is now too restrictive should be expanded so as to grant cooperatives in these States similar broad powers.

Now under consideration by the Texas Federation of Cooperatives are the closer coordination of cooperatives and more activity in the refining and marketing fields. At present, while there are numerous cooperative cotton gins, there is no cooperative textile mill, although rice growers', cotton gin cooperatives and cooperative feed mills use hundreds of thousands of bags each year. Other textile products are also needed in great quantities.

Synthetics are too new for present cooperative production, and offer too many obstacles to free enterprise, such as patent rights on processes, large capital outlays, needed research, and other factors; cooperative shops to make metal tubes, rods, and sheets into finished products should be possible.

The grain producer cooperatives, now primarily marketing cooperatives, might engage in the production of grain alcohol and essential materials for synthetic rubber production, and food products such as flour, cereals, macaroni, and mill feeds. There is also a great and growing need for a feed and seed processing and distributing cooperative (such as the Grange League Federation and others) to service the increasing dependence on livestock production in the Valley.

Means of Developing Cooperatives

The philosophy of the cooperative movement is in close harmony with the Valley plan for matching

human needs and material resources. Historically, cooperatives have minimized State lines and have looked to community, regional, national, and world economic organization on democratic principles.

The present regional structure of the cooperatives should not be changed to form one region coincident with the area of the Arkansas Valley. Rather all regional cooperative organizations and Federal agencies, such as the Rural Electrification Administration, Farm Security Administration, and Bank for Cooperatives, should be encouraged to help in the sound promotion of cooperatives within the Valley.

The great need is for a broad, thorough educational program to acquaint all with the deeper meaning and social significance of the cooperative movement as a growing part of free enterprise. At present, too many members think of cooperatives as merely another way to do business.

Coordination among existing cooperatives and cooperative agencies is also a prime requisite in furthering this type of enterprise. Another need in this direction is a liaison between cooperatives and a strong research council.

The study group method, whereby people in various neighborhoods study their problems and later exchange ideas at community meetings, has proved a particularly successful method of education for cooperatives. The origin and maintenance of such study groups throughout the entire Valley is a part of the educational plan for the area. In this connection, there is need for the preparation and acquisition of a new body of material on cooperatives, direct and simple in statement and dealing in a practical way with the problems of the people and approaches to their solution.

In summary, machinery to promote cooperatives—consumer, producer, marketing, and processing—should be an important part of the social adjustment program for the region.

RECREATION

Recreation should rank high in importance in the program for harmonious development of human and material resources of the Valley, for it has much to do with the quality of individual living and social well-being.

Recreation has its role also in the popular movement which must acquaint the people with their vast potentialities and arouse them to a realization of the challenges of full employment in a program of industrialization and conservation.

Travel can bring an interchange of ideas and intimate knowledge of the wide variety of scenic, soil, mineral, water, power, forest, industrial, and cultural resources. Improvement of highways, of waterways and airways will promote such travel. Likewise, trails for hiking, cycling, and horseback riding should be provided. Under suitable conditions a chain of youth hostels should make possible inexpensive journeying on foot or bicycle from one end of the Valley to the other.

Rapid urbanization has increased the need for occasional escape to a more natural environment. Disintegrating forces in modern civilization demand provision for family recreation in country as well as town and city. Especially popular forms of outdoor recreation for which facilities should be provided are sightseeing, fishing, picnicking, swimming, camping, hunting, boating, nature study, sports and games, horseback riding, and organized camping for urban and rural youth.

Present Recreational Background

Two natural recreation areas of national importance are situated in the Arkansas Valley—the Ozark-Ouachita Highlands and the Eastern Slope of the Rocky Mountains. (Fig. 13).

Presenting as they do an attractive panorama of rugged, near-mountainous hills, rock formations, forests, fast-running streams, voluminous springs, lakes and caves, abundant wildlife, and 20 rivers, the Ozark-Ouachita Highlands can and do serve a large part of the Valley. Ringed by cities just outside the Valley boundaries—Tulsa, Okla.; Kansas City, Kans.; St. Louis and Kansas City, Mo.; Memphis, Tenn.; and Dallas and Fort Worth, Tex.—these highlands are the nearest natural recreation region for these cities and for many hundreds of square miles of adjoining territory.

The Eastern Slope of the Rockies is vacation land of scenic grandeur and cool relief from the torrid summer heat of the plains. Developments in both these areas are lacking; possibilities are great.

Rich wildlife resources are to be found in Arkansas and northern Louisiana. Most of the waterfowl of the great Mississippi flyway winter there. Wild ducks are counted by the millions and fifty thousand hunters take a million ducks and geese each winter. One of the 15 wildlife refuges comprises 110,000 acres.

State and Federal Developments

Artificial lakes, such as the one at Denison, Tex., covering 95,000 acres, add to the Valley's recreation opportunities. However, while these lakes have been multiplying, certain areas—particularly the High Plains—are much in need of such developments.

Thirty Federal recreation areas now provide week-end and vacation facilities, and 35 State parks have

been developed within the Valley. In the Federal group there are 2 national parks, 1 national monument, 8 national forests, 2 game refuges, 10 land-utilization projects, and 6 Soil Conservation Service reservoirs. Approximately 110,630 acres of this Federal land are now devoted to recreational uses. The 1938 attendance counts and official estimates indicated that more than 2,500,000 visitors enjoyed the available facilities.

Of the areas of State park calibre, 9 are in the Missouri State Park System, 6 in Arkansas, 4 in Kansas, 9 in Oklahoma, 4 in Texas, 1 in New Mexico, and 1 in Colorado. There is a total of 97,362 acres in this group, which accommodated nearly 2,000,000 visitors in 1938. Increased travel during 1939–41 overtaxed the facilities on these Federal and State areas.

Why an Investment in Recreational Facilities?

The establishment, development, and operation of public outdoor recreational facilities at all levels of government constitute a public service and are not intended as money-making investments. The service rendered is accepted by the public as a valuable social contribution to its welfare. Therefore, the financing of these benefits is a public responsibility just as is the public financing of schools and highways.

However, recreational activities, particularly of the vacation travel type, are conducted on such a huge scale in this country that in those areas having unusual recreational assets, the income of the tourist business is a major factor in the local economy.

Basis for Public Expenditures

In order to arrive at a possible financial basis and justification for public expenditures on recreational areas in the Arkansas Valley, certain indices of the volume of annual tourist retail expenditures were followed. For example, the report by the United States Travel Bureau on travelers' retail expenditures in 1939 stated that $5,751,000,000 (an average of $45 per capita) was spent that year by tourists in the United States. Based on the Valley-States' averages, the Valley's proportionate share of this national expenditure should have been $335,552,000.

Since the Valley contains 2 major recreational zones of national importance, and is criss-crossed with highways carrying heavy tourist travel, it can be assumed that more tourist expenditures come into the Valley than go out of it. For instance, it was estimated by the Conoco Survey, the American Automobile Association, and the United States Travel Bureau that 2,450,000 cars carrying 5,822,000 tourists visited the Ozark country in Arkansas in 1937 and that tourist expenditures were approximately $85,000,000. In Missouri, the Ozark Recreational Association estimates an income of $80,000,000 per year from the tourist business; while it is believed that in New Mexico the number of tourists equals 10 times the resident population of that State and brings an annual income of $50,000,000. In the Colorado State Highway Planning Report, it is estimated that out-of-State recreational travel brings an income of $32,000,000 annually.

In its 1940 analysis of the economic value of vacation travel, the United States Travel Bureau stated that the increased importance of tourist expenditures in maintaining the stability of State economy has been demonstrated throughout the Nation in the past few years. In those States containing substantial acreage set aside for recreational utilization, the per capita return in tourist expenditures runs from $60 to $91, as against the national average of $45. It is further stated that tourist interests are sensitive to promotional stimulus, as illustrated by the fact that there has been an average increase of 25 percent in tourist travel in those States actively promoting it. The figures show a 500 percent return on promotional investments.

If the recreational facilities of the Arkansas Valley are brought up to a minimum standard, and the potential facilities are developed and promoted, it can be assumed that the increased tourist business experienced in other parts of the country would follow. For instance, if $20,000,000 were expended each year for 5 years on the recreational program, it is probable that the increased tourist business would approximate an additional $125,000,000 per year.

Recreational accessories, such as pleasure cars and sports equipment—including clothes, guns, fishing tackle, shells, golf clubs, balls, tennis rackets, films, etc.—are now largely manufactured and distributed outside the Valley. Some $40,000,000 are expended annually on guns, ammunition, fishing tackle, and other fishing and hunting equipment. If some of these products were manufactured locally, and if the local handicrafts, such as ceramics, art work, jewelry, souvenirs, and food specialties, were exploited in the Valley, the tourist income would be still greater.

The vast sum expended by tourists is not concentrated within any one industry, and because it flows into all retail channels, it is available for use almost immediately, thereby increasing the turnover of the Nation's money and its buying power.

Recreation Needs

Public outdoor recreation facilities in the Arkansas Valley are inadequate to meet the existing needs for all types of use. Deficiencies in city, town, community, and county playgrounds, parkways, picnic groves, parks, and recreation areas are pointed out in all previous studies and surveys of the situation.

Existing public recreation areas and parks for va-

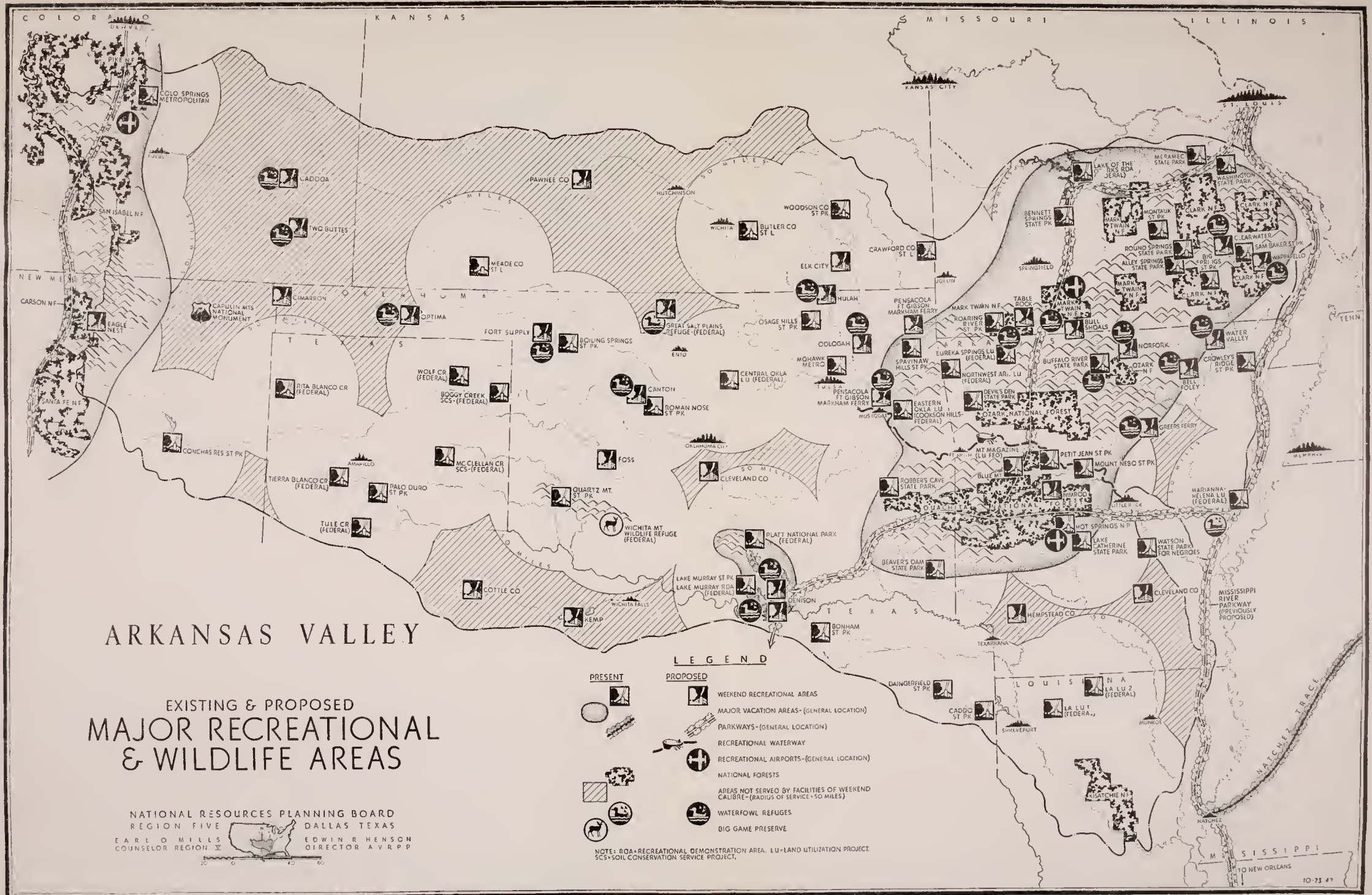

FIGURE 13.

(Face p. 104)

cation and week-end use are fairly well distributed over the Valley, except in the northwestern section. However, these sites are for the most part insufficiently developed to accommodate the demand.

As the major vacation areas of national significance within the Arkansas Valley, the Ozark-Ouachita Highlands and the Eastern Slope of the southern Rocky Mountains must meet the heaviest tourist visitation. Also, the Arbuckle Mountain district in Oklahoma, including Platt National Park, the Lake Murray State Park, and the Denison Reservoir, is a terminal objective of considerable vacation travel.

In these three national vacation areas provision should be made to accommodate greatly increased tourist travel. It can be predicted that a portion of this traffic will come in increasing numbers by airplane, and consideration should be given to the encouragement of recreation travel by converted bomber planes after the war as one means of stabilizing the vast war airplane industry on a peace-time basis. Air transport should be cheaper, safer, and more enjoyable than long-distance travel by car. Supplemented at flight terminals with the availability for rent of inexpensive small cars of the Army "jeep" and "peep" types, of which there may be a post-war abundance, air transportation may eventually supplant the automobile as the predominant mode of long-distance pleasure travel.

With this prospect in mind, it is recommended that airport sites for pleasure traffic be selected, developed, and operated in the three principal vacation areas of the Arkansas Valley.

Also in these three areas, extensive hiking, bicycle, and horseback riding trails should be provided to meet and encourage this most wholesome type of recreation. These trails should be planned and constructed in connected loops of varying mileage and should be provided with inexpensive overnight lodge accommodations. They can be located in conjunction with scenic highways or parkways which are also recommended as a necessary development of the recreational resources of the Valley.

River boat travel is another most enjoyable form of relaxation and some of the rivers of the Valley will offer opportunities for this sort of recreation. That part of the Arkansas River stretching through the Ozark country from Muskogee, Okla., to the Mississippi River, should be provided with houseboats and with occasional docking facilities at scenic stops and supply stations.

Bringing public outdoor recreational areas, systems, facilities, and possibilities up to acceptable minimum standards for all types of use for the residents and visitors of the Valley, would require:

1. Playgrounds within easy walking distance (quarter of a mile) of all children.

2. Playfields and neighborhood centers within a mile of all citizens.

3. Natural or artificial parks extensive enough to preclude overuse and situated within 2 miles of all citizens.

4. Improvement and maintenance of water quality on selected streams to meet standards suited to recreational use.

5. Parkways along waterways and as connecting links between major units of the recreation area system.

6. Recreation areas for water sports, picnicking, and day and overnight camping and hiking, within 25 miles of everyone in the Valley. These areas should provide for baseball, softball, tennis, volleyball, badminton, horseshoes, swimming, musical and dramatic presentations, competitive sports, festivals, pageants, dancing.

7. Extensive public vacation areas characterized by forests, rugged terrain, lakes and streams. On such properties are needed camp grounds, cabin colonies, group camps, and various public resorts. The shoreline of major lakes and streams should be reserved for public use.

Proposed Program of Investment

An adequate recreational program in the Arkansas Valley would necessitate a 5-year program of capital improvements and additions involving total expenditures of the following approximate amounts:

Town and city playgrounds and parks:		
170 villages at $10,000 average	$1,700,000	
39 towns at $20,000 average	780,000	
8 cities at $100,000 average	800,000	
8 metropolitan cities at $300,000 average	2,400,000	
		$5,680,000
County parks and water recreation areas:		
330 counties at $50,000 average		16,600,000
State parks and recreation areas:		
Improvements existing areas, 33 at $200,000		6,600,000
8 undeveloped State sites at $400,000		3,200,000
Federal areas:		
National Parks improvement; existing areas		900,000
National Forests recreation improvement; existing areas		3,854,000
National Forest wildlife improvement; existing areas		720,000
National Forest proposed new areas (recreation)		2,841,000
National Forest proposed new areas (wildlife)		2,465,000
National Wildlife Refuges — existing areas improvements		1,250,000
National Wildlife Refuges proposed new areas		3,000,000
Recreation developments and wildlife improvements at 25 major power, flood, or irrigation reservoirs		10,000,000
Recreation developments at 20 minor proposed power, flood, or irrigation reservoirs at $40,000 each		800,000

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Recreation developments at 20 minor proposed power, flood, or irrigation reservoirs at $40,000 each		800,000

Federal areas—Continued.	
Five recreation reservoirs in areas not served by any existing or proposed water facilities at $350,000 each	$1,750,000
One thousand miles of parkway at $40,000 per mile	40,000,000
Five hundred miles of hiking, bicycle, and horse trails at $300 per mile	150,000
Twelve trail lodges at $20,000 each	240,000
Ten boat houses (floating lodges), at $100,000 each	1,000,000
Three recreation airports at $1,000,000 each	3,000,000
Total	$104,050,000

Of this total expenditure, approximately 10 percent would be for land acquisition, 40 percent for materials, and 50 percent for labor and supervision.

The State planning boards in all States would be expected to arrange for the desired participation of the people, individuals, institutions, State agencies, municipalities, and local units of government within the State in planning local recreational programs and facilities. In connection with this work consideration would be given to aspects of the regional plan affecting their communities.

Recreational development of an area like the Ozark-Ouachita Highlands requires the cooperation of the people of Arkansas, Missouri, and Oklahoma affected by such a development. This cooperation may be worked out through the regional field office of the National Resources Planning Board and the Planning Boards of the interested States.

EDUCATION

The implementing of specific proposals relating to people, land, water, industry, and power calls for individual and group adaptations that are essentially educational. Industrialization, for example, implies more than mere mechanization; along with it must come education for leadership, education in public attitudes, and education for skills. Any democratic program for conserving water, land, and mineral resources must therefore rest on and grow out of popular attitudes which put right values on these Valley assets. Education can develop such concern.

On the Valley Level

Education on the Valley level should coordinate the effort of regional agencies, further industrial research, stimulate elementary and adult education, and provide for recreation.

Coordination

Operating through many channels are various Federal, State, and private agencies. These have been evolved out of and are designed to meet specific needs of the Valley. If thoroughly integrated in purpose and procedure, these agencies, with their already vast personnel resources, might be almost enough to bring about needed Valley adjustments. But some of them are so extensive that few members of their own personnel understand the scope and workings of their own programs.

A Valley-wide effort toward integration of all constructive forces is clearly needed. While this effort might have administrative aspects, it would be in essence educational, and educational techniques must be used to emphasize, in the thinking of the personnel of all agencies, the interrelatedness of the problems of the region, and to unite all their efforts in using the resources to bring full employment and a good level of living to the Valley.

Research

There are historic reasons for the retardation of the South in the industrial movement. The South's backwardness in scientific inquiry has roots in the same causes. Until very recently the great research laboratories of the Nation, whether sponsored by private industry or Federal or State government, were almost all in the North. The research on oil refining, naval stores, and more recently, the Regional Research Laboratory of the Department of Agriculture at New Orleans are examples of increasing emphasis on research on the utilization of southern raw materials. Although far from adequately financed, State institutes are making increasingly important contributions in this field. The various foundations and private industry are making important contributions for research work.

As previously suggested, a means of blending and relating these research efforts through a council is desirable. The problem of development of a commercial effort from a laboratory method requires considerable expenditure in pilot plant experimentation. Valuable contributions to the industrialization of this area would come from the suggested laboratory designed to try out processes developed by research as these processes meet the needs of the region. Education has an important function to perform in keeping the public informed and supporting efforts to develop methods of utilizing the resources of the Valley through well equipped and financed research work.

Colleges and universities, in addition to academic and

professional training, have a great opportunity to lead in developing attitudes, concepts, and methods of utilizing the resources of the region for the betterment of all the people of the Valley and the Nation. More and more these institutions will concern themselves with the utilization of local resources and be rewarded by more generous funds for this effort as their contribution is felt by the people they serve.

These institutions now train the workers who become the research men of the larger private industries. The benefits from such research may indirectly benefit the people of the area. However, in the interest of a healthy private competition, too exclusive an ownership of the patent rights to processes may be detrimental. Likewise, "public patents" free to all may actually delay development of a process inasmuch as a company may find, after expending large sums in perfecting, experimenting, and developing a market for a product, that other companies freely come in and reap the benefit of their work without paying their share of development costs. Some form of limited exclusive use of such public patents may be necessary for proper development.

But there is need of other than industrial research. More research is needed, for example, in conservation of resources and organization of farms, in diets and levels of living in sociology, agricultural economics, education, nutrition, and housing. This region should assume its just responsibility, proportionate to its enormous size, great population, varied and extensive resources, to push open the doors on new vistas of knowledge of natural laws in general and of human growth and behavior in particular.

Colleges

In institutions of higher learning throughout the Valley, work should be designed to motivate the desire for human service in terms of the region's needs and resources, and to multiply the knowledge and skills needed in engineering, in manufacturing, in research, in agricultural production, in marketing, in government. Every possible assistance should be given to colleges and universities of the Valley in soundly hastening the transition from purely academic to functional education.

Teacher-training institutions can be especially influential in regional development, for every teacher is charged daily with instructing about two-score young people. Accordingly, it is essential that the instruction in these institutions be related as closely as possible to solving the problems of the Valley in terms of its great resources. Some excellent materials have recently been prepared to further this work; others are needed for the promotion of these purposes. The nature of instruction should be increasingly realistic and dynamic.

On the Community Level

Public Adjustment

A Valley program calling for changes as profound as full employment will demand both general and particular adjustments.

To provide electric current at moderate rates to 682,000 new homes is not to assure optimum use of current by those who have grown up in a routine of meeting demands for repetitions chores with their own strength. Only slowly will they change to mechanical means for washing, ironing, sewing, pumping, sawing, cooking, cooling, ventilating, cleaning, and the like. The Rural Electrification Administration program for demonstrating such equipment, and placing needed items in the homes on trial, with option to buy over a period of time, is one kind of education needed in the Arkansas Valley.

Sanitary Facilities

Hookworm cannot be eliminated by tests, medication, and construction of outhouses, unless the people can be educated to use, as well as have, sanitary facilities. Running water, with proper sewage disposal, will not be in universal demand or use unless a practical program of personal adjustments is instituted.

Full employment will demand deep-seated adjustments on the part of hundreds of thousands of farmers. Many of our urban problems result from presuming that the shift from farm to urban living can be left to chance. Institutes for industrialization should be held throughout areas of unemployment and underdevelopment, acquainting those in need with the meaning of industrialization, teaching skills in terms of aptitudes and demands, and pointing the way to family adjustment in new employment.

Community Education

But beyond individual and family adjustment, the plan for the Valley calls for united community action to realize the progress that is possible.

Community education should center about problems. People think only when they are confronted with problems. They grow only as they solve problems. Community councils organized by the people of the community for discussion, planning, and action can assure a broad, well-rounded development.

Health must be studied as a matter of community, as well as individual, concern for all are affected by the health of all. Housing, as it affects health, self-respect and group attitude, concerns us all. And so with the

prevalence of crime, overcrowding on farm lands, high cost of credit to the small borrower, waste of land through erosion, waste of gas and oil through unwise exploitation, waste of forests through fires and reckless cutting, lack of industrialization, undeveloped water power, needed recreational resources, cost of floods, want of knowledge of industrial skills, further democratizing of industry, beautification of highways, stamping out of pests of all kinds, further discovery of natural resources, essential need of industrial and other research.

We must see all these and other problems in their inter-relatedness, see them against the background of a region, a democratic form of government and a people able to solve them largely through their awakened understanding and their own effort.

The School's Part

There is need of an integrated effort to acquaint the hundreds of thousands of young people of the Valley with the potentialities and problems of their environment, so that they may be encouraged to throw their weight behind the programs of community development. These young people constitute a powerful resource both in planning and in the execution of plans. But they tire of dull, static, remote studies. Many capable boys and girls drop out of school who would continue and eagerly take part in a more constructive program looking toward the welfare of all. They thus multiply competition for jobs while they limit their ultimate usefulness.

In this Valley, there are 130,000 or more youths in each age group between the ages of 15 and 20, inclusive, or a total of 780,000. Although there are wide variations within the Valley, about one-fourth of these boys and girls enter high school; about one-half of those who enter complete the courses. Thus, about 641,875 young people of this age group are either out of school, unemployed, underemployed, or withholding a job from an adult. High-school attendance and graduation are lowest in the east and better toward the west and north.

Schools should enrich their programs and increase their holding power so that no youth under 18 years of age would be part of the labor force, and none older than that age would be without education for economic competency.

Much benefit has come in those cases, now rapidly increasing in number, where schools have ventured intelligently on such enterprises as hot-lunch programs; hotbeds for producing early spring plants; landscaping the grounds around schools, homes, and public buildings; draining malaria-producing ponds; building sanitary outhouses (in conjunction with other hookworm-control measures); performing elementary but needed research; making their own playground equipment; operating a hatchery; equipping a materials bureau; developing a folk museum; operating school cooperatives; helping direct traffic; interviewing people of concern on public matters; seeking new community resources; checking erosion; tending demonstration forests.

New study material should be prepared for the Valley as a whole, with separate supplementary treatment of the resources of each of the subregions, or areas. This material should be adapted to different age levels, from elementary school through college; it should be functional but, by its constructive viewpoint and graphic presentation, stirring to the imagination and social consciousness of the students. Such texts should lead the students into physical as well as mental participation in the program. True education would thus lead into most effective citizenship.

School administration has constantly broadened. It is now jointly local, State, and Federal. There is need of some further shift toward Federal support and supervision to insure more equal opportunity to all children of the Valley. Now the annual per-pupil cost of education for some children of the Valley is 10 times that of some others. Such discrimination tends to perpetuate class distinctions and other undemocratic tendencies. The resulting continued ignorance among the depressed groups threatens the health and security of all.

Federal aid should help provide vocational schooling. A start has been made through the George Dean Act, providing training in diversified occupations. In this training and guidance program, students study various occupations at the school, and work under supervision in shops of the community. But local as well as State and Federal funds should be used in providing a consistent and expanding program designed to develop scientific habits of thought and skills in manipulation. Such work should be a part of the entire educational program.

Growth into the new citizenship will demand more than familiarity with textbook truths. There will be related mental and physical participation in purposes appropriate to the abilities of the students and real to them in social awareness. Such citizenship will be concerned with human and material values within the community, the region, the Nation, and the world.

The Program for Education

The best means for strengthening education within the Arkansas Valley will be to demand of education the performance of important functions. There are no

problems in the Valley that cannot be solved by a progressively educated public. Schools can be broadened to serve the region in these respects:

1. Development of an awareness of the Valley's needs and resources.

2. Creation of a justifiable confidence that, through adjustment, all the basic needs of the people can be provided.

3. Development of a cooperative attitude based on the service motive without related self-interest.

4. Instruction in the number and nature of present constructive agencies within the Valley.

5. Initiation of greatly needed research.

6. Training of all youth to the age of 20 in suitably varied schools. Provision should be made for the necessary cost of such instruction, and students should be permitted to increase their earning powers gradually from about the fifteenth through the twentieth years, but should be kept out of the regular labor force.

7. Establishment of special residence centers, conservation camps, trade schools, courses in regional agricultural adjustment, business schools, and other arrangements to provide training and guidance to those not adaptable to present high schools and colleges.

8. Assistance to all schools in growing in the related directions of functionalism, continuity, interest basis, activity, integration, and democracy.

9. Education for wise use of leisure.

10. Absorption of all demobilized soldiers and war workers who wish to continue their training into the regular or special schools and colleges, giving financial aid and guidance as needed toward completion of study and adjustment in industry or agriculture.

11. Broadening of interests to include the order and security of the Nation and world through necessary legislative, judicial, and executive means.

12. Stimulation of adult participation in planning for community needs, for employment opportunities, for housing, and for conservation and best use of resources.

To do all of these things in the Valley, means must be found to insure a seasonable salary to all qualified teachers and a reasonably continuous employment. A staff of such teachers, thoroughly informed and believing in the people, the resources, and the opportunities of the Valley, can do more than millions of dollars spent in other ways to bring a reasonable prosperity, health, and satisfaction to the people of the Valley.

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